A COMPARATIVE STUDY OF ENERGY SYSTEMS, WASKAGANISH, QUEBEC

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A COMPARATIVE STUDY OF ENERGY SYSTEMS

WASKAGANISH, QUEBEC

Prepared for:

Cree Regional Authority
and
Waskaganish Band Council

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With contributions from:

Indian and Northern Affairs Canada
and
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1. EXECUTIVE SUMMARY

Objective

The objective of this study was to determine which energy supply scenario could provide energy at the lowest cost for Waskaganish.[1] This analysis has to be performed following a clearly defined approach.

General Approach

The study is divided into four parts:

- the assessment of the Total Energy Demand;
- the definition of eight energy systems able to meet this Demand;
- the definition of the energy supply scenarios available for Waskaganish;
- a comparative analysis of these scenarios.

The Total Energy Demand was first estimated for 1983-1984 and then forecasted for the next fifty years. The Total Energy Demand was then broken down by sector and final use. The houses managed by the Cree Housing Corporation were taken to constitute the Residential Sector while all other buildings were included in the Commercial and Institutional Sector. Two final uses were considered in this study: the basic needs (all uses not related to heating e.g. lighting, cooking, refrigeration, appliances) and the heating needs. The forecasts are based on population growth estimates.

Eight energy systems are studied as specified in the Terms of Reference. These systems are:

- diesel generators
- oil furnaces
- wood furnaces
- thermoelectric generators
- wood gasifier
- windmills
- mini-hydroelectric power plant
- interconnection with the Hydro-Quebec grid.

The wood furnaces are only considered for the Residential Sector. Cost evaluation of the mini-hydroelectric power plants is derived from the ABBDL-TECSULT study entitled "Prefeasibility study of mini-hydro potential in the vicinity of Rupert House". This study proposed two alternatives, a 5.7 MW power plant meeting the total energy demand for thirty years and a 1.0 MW power plant meeting the basic electricity demand for thirty years. The present study being done for fifty years, the cost estimates have been redone for two larger power plants: 2.5 MW power plant to meet the basic demand and a 10 MW power plant to meet the total demand for fifty years.

1, 2 See page x

The eight energy systems are then combined to form the energy supply scenarios available to the community. A first selection of the more logical scenarios is performed at this level to retain three to six true alternatives for Waskaganish.

These scenarios are evaluated based on their total cost for a fifty year period and on their social and environmental impacts. Conclusions and recommendations follow identifying the optimal energy supply scenario for the community of Waskaganish.

Conclusion and recommendations

The total energy demand in 1984 is estimated at 7 190 703 KWh and will reach 25 058 871 KWh in 2033. The total peak demand load is estimated at 2.9 MW in 1984 and will rise to 10.0 MW in 2033.

Following the presentation of the eight energy systems previously enumerated, three were discarded for technical reasons. They are: the gasifier, the thermoelectric generator and the windmill.

Fifteen energy supply scenarios were then formed from the various combinations of the remaining five energy systems.

Ten were quickly discarded for obvious reasons, leaving five valid energy supply scenarios to be studied thoroughly. They are:

Scenarios	Energy systems providing	
	Basic energy	Heating energy
Scenario #1	Diesel generators	Wood furnaces Oil furnaces
Scenario #2	Transmission line	Wood furnaces Transmission line
Scenario #3	2.5 MW mini-hydro	Wood furnaces Oil furnaces
Scenario #4	10 MW mini-hydro	10 MW mini-hydro
Scenario #5	Transmission line	Transmission line

Since a previous report[3] prepared by COGESULT recommended for the residential heating an energy mix including 75% wood - 25% oil, it is assumed that the wood furnaces will supply 75% of the residential heating needs in the scenario #1, #2 and #3.

The present diesel generators are considered available without extra cost. Since they are owned by Indian and Northern Affairs Canada, this matter will have to be negotiated. The present salvage value of these equipment is 648 000$.[4]

The present worth of these scenarios is presented in Table 1.

Table 1

Present Worth of the energy supply scenarios (discount rate = 4%)

Scenarios	Present Worth
Scenario #1	41 357 000$
Scenario #2	37 538 000$
Scenario #3	30 037 000$
Scenario #4	43 563 000$
Scenario #5	36 908 000$

A discount rate of 4% is used to calculate the Present Worth of each scenario. A sensitivity analysis is presented for variations of the discount rate.

The scenario #3 remains the cheapest with discount rates of 2 and 6%. The scenario #1 which includes utilization of diesel generators for basic electricity production is very sensitive to the discount rate variations. It is the more expensive scenario at 2% and the least expensive at 8%.

No scenario has a significant impact on the environment. On the social side, the scenario #3 generates the greater level of economic activity, on short and long term basis. Utilization of wood furnaces however requires more attention from the user. Scenario #4 and #5 have only a short term impact on the local economic activity.

3, 4 See page x

Cogesult consequently recommends to the Cree community of Waskaganish to adopt the scenario #3 which implies wood and oil heating for the residential sector, oil heating for the commercial and institutional sectors and the construction of a 2.5 MW mini-hydroelectric power plant to provide the basic electricity to the whole community.

Cogesult also recommends to the Cree community to study the possible benefits related to the implementation of an energy management system which would recuperate the energy surplus occasionnally generated by the mini-hydro. This would reduce the cost of this scenario.

It is assumed in this study that the construction cost of the transmission line was not negotiable. A financial participation of Hydro-Quebec in this project could make the scenarios including the transmission line more interesting. Cogesult recommends that the Cree community undertake such negotiations with Hydro-Quebec before making a final decision on the adoption of such an energy supply scenario for Waskaganish.

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[1] Waskaganish was formerly known as Rupert House and Fort Rupert

[2] The study entitled "Prefeasibility Study of Mini-Hydro Potential in the Vicinity of Waskaganish, Quebec" was prepared for the Council of the Crees of Waskaganish and for the Cree Regional Authority with a contribution from the Remote Community Demonstration Program of Energy, Mines and Resources Canada. (April 1984)

[3] Firewood Demand and Supply Study for Eastmain, Wemindji and Waskaganish, September 1984, p. 53. The report was prepared for the Grand Council of the Crees (of Quebec) and the Cree Regional Authority with financial contributions from Indian and Northern Affairs Canada and the Remote Community Demonstration Program of Energy, Mines and Resources Canada.

[4] Straight-line amortization and utilization rate of 50%.

ÉTUDE COMPARATIVE DES SYSTÈMES ÉNERGÉTIQUES POUR WASKAGANISH (QUÉBEC)

Résumé

But

Le but de cette étude était de déterminer quel scénario d'alimentation énergétique pourrait fournir de l'énergie au coût le plus bas pour Waskaganish.[1] Cette analyse doit être effectuée selon une méthode clairement définie.

L'étude se divise en quatre parties:

- l'évaluation de la demande totale en énergie;
- la définition des huit systèmes énergétiques capables de satisfaire à cette demande;
- la définition des scénarios d'alimentation énergétique disponibles pour Waskaganish;
- une analyse comparative de ces scénarios.

On a d'abord évalué la demande totale en énergie pour 1983-1984 puis on a établi les prévisions pour les cinquante prochaines années. On a ensuite réparti la demande totale en énergie selon le secteur et l'usage final. On a pris les maisons gérées par la Société de logement crie pour constituer le secteur résidentiel et on a inclu dans le secteur commercial et institutionnel tous les autres immeubles. On a étudié deux usages finals: les besoins de base (tous les usages qui ne sont pas reliés au chauffage, c'est-à-dire l'éclairage, la cuisine, la réfrigération, les appareils ménagers) et les besoins de chauffage. On a établi les prévisions en se basant sur des estimations de croissance de la population.

Huit systèmes énergétiques ont été étudiés tel que précisé dans le mandat. Ces systèmes sont les suivants:

- génératrices diesel
- chaudières au mazout
- chaudières au bois
- générateurs thermo-électriques
- gazogènes
- éoliennes
- mini-centrales hydro-électriques
- interconnexion avec le réseau d'Hydro-Québec

Les chaudières au bois ne sont considérées que pour le secteur résidentiel. L'estimation des coûts des mini-centrales hydro-électriques provient de l'étude ABBDL-TECSULT intitulée "Pre-étude de faisabilité

d'une mini-centrale hydro-électrique au voisinage de Waskaganish"[2] préparée pour le Conseil des Cris de Waskaganish et l'Administration régionale crie. Cette étude proposait deux solutions, une centrale de 5,7 MW pour répondre à la demande énergétique totale pour une période de trente ans et une centrale de 1 MW pour répondre à la demande de base en électricité pour une période de trente ans. Étant donné que la présente étude couvre une période de cinquante ans, on a refait les estimations avec deux centrales plus grandes: une centrale de 2,5 MW pour répondre à la demande de base et une de 10 MW pour satisfaire à la demande totale pour cinquante ans.

On a ensuite combiné les huit systèmes énergétiques pour former les scénarios d'alimentation énergétique disponibles pour la collectivité. On a alors effectué une première sélection des scénarios les plus logiques à ce niveau pour garder de trois à six possibilités réelles pour Waskaganish.

On a évalué ces scénarios en se basant sur leur coût total pour une période de cinquante ans ainsi que sur leurs répercussions sociales et environnementales. Suivent ensuite les conclusions et recommandations identifiant le meilleur scénario d'alimentation énergétique pour la collectivité de Waskaganish.

Conclusion et recommandations

La demande totale en énergie pour 1984 est évaluée à 7 190 703 KWh et atteindra 25 058 871 KWh en l'an 2033. On estime la charge de demande de pointe totale à 2,9 MW pour 1984 et elle augmentera à 10 MW en 2033.

Suite à la présentation des huit systèmes énergétiques énumérés auparavant, trois d'entre eux ont été éliminés pour des raisons techniques. Ce sont: le gazogène, le générateur thermo-électrique et l'éolienne.

On a ensuite établi quinze scénarios d'alimentation énergétiques à partir des diverses combinaisons des cinq systèmes énergétiques qui restaient.

On en a vite éliminé dix pour des raisons évidentes, il restait donc les cinq scénarios d'alimentation énergétique valables suivants devant faire l'objet d'une étude approfondie:

Scénario	Systèmes énergétiques fournissant	
	Énergie de base	Énergie de chauffage
n° 1	Génératrices diesel	Chaudières au bois Chaudières au mazout
n° 2	Ligne de transport	Chaudières au bois Ligne de transport
n° 3	Mini-centrale de 2,5 MW	Chaudières au bois Chaudières au mazout
n° 4	Mini-centrale de 10 MW	Mini-centrale 10 MW
n° 5	Ligne de transport	Ligne de transport

Étant donné qu'un rapport précédent[3] préparé par Cogesult recommandait le chauffage résidentiel au moyen d'un mélange d'alimentation énergétique comprenant 75 % au bois 25 % au mazout, on assume donc que les chaudières au bois fourniront 75 % des besoins de chauffage résidentiels dans les scénarios 1, 2 et 3.

On considère les génératrices diesel actuelles comme étant disponibles sans coût additionnel. Étant donné qu'elles sont la propriété des Affaires indiennes et du Nord canadien, il faudra cependant négocier cette question. La valeur de récupération actuelle de ce matériel est de 648 000 $.*

Valeur actuelle des scénarios d'alimentation énergétique
(taux d'escompte: 4 %)

Scénario	Valeur actuelle
n° 1	41 357 000 $
n° 2	37 538 000 $
n° 3	30 037 000 $
n° 4	43 563 000 $
n° 5	36 908 000 $

On a utilisé un taux d'escompte de 4 % dans le calcul de la valeur actuelle de chaque scénario. Une analyse de sensibilité est présentée pour les variations du taux d'escompte.

Le scénario n° 3 demeure le moins cher avec des taux d'escompte de 2 et 6 %. Le scénario n° 1 qui comprend l'utilisation des génératrices diesel pour la production de base d'électricité est très sensible aux variations du taux d'escompte. Il s'agit du scénario le plus cher à un taux d'escompte de 2 % et du moins cher, à 8 %.

Aucun scénario n'a de répercussion importante sur l'environnement. Du point de vue social, le scénario n° 3 génère le plus haut niveau d'activité économique à court et à long terme. L'utilisation de chaudières au bois demande toutefois plus d'attention de la part de l'utilisateur. Les scénarios 4 et 5 n'ont que des répercussions à court terme sur l'activité économique locale.

Par conséquent, l'expert-conseil recommande à la collectivité crie de Waskaganish d'adopter le scénario n° 3, c'est-à-dire le chauffage au bois et au mazout pour le secteur résidentiel, le chauffage au mazout pour les secteurs commercial et institutionnel et la construction d'une mini-centrale hydro-électrique de 2,5 MW pour fournir l'électricité de base à toute la collectivité.

L'expert-conseil recommande également à la collectivité crie d'étudier les avantages éventuels reliés à l'implantation d'un système de gestion de l'énergie qui récupérerait le surplus énergétique produit à l'occasion par la mini-centrale. Ceci réduirait le coût de ce scénario.

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* Amortissement linéaire et taux d'utilisation de 50 %.

Dans cette étude on a assumé que le coût de construction de la ligne de transport n'était pas négociable. Une participation financière d'Hydro-Québec dans ce projet pourrait rendre les scénarios plus intéressants y compris celui de la ligne de transport. L'expert-conseil recommande que la communauté crie entreprenne des négociations avec Hydro-Québec avant de prendre une décision finale quant à l'adoption d'un scénario d'alimentation énergétique pour Waskaganish.

Cette étude a été entreprise pour l'Administration régionale crie et pour le Conseil de bande de Waskaganish par Cogesult Inc. avec les contributions financières des Affaires indiennes et du Nord canadien et du Programme de démonstration dans les collectivités éloignées, d'Énergie, Mines et Ressources Canada.

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1 Waskaganish était anciennement connu sous les noms de Fort Rupert ou de Rupert House.

2 Cette étude a été effectuée avec une subvention du Programme de démonstration dans les collectivités éloignées d'Énergie, Mines et Ressources Canada.

3 Étude de la demande et de l'approvisionnement de bois de chauffage pour les collectivités québécoises d'Eastmain, Wemindji et Waskaganish, septembre 1984, p. 53. Cette étude a été effectuée pour le Grand conseil des Cris (de Québec) et pour l'Administration régionale des Cris avec des subventions des Affaires indiennes et du Nord Canada et du Programme de démonstration dans les collectivités éloignées d'Énergie, Mines et Ressources Canada.

2.0 INTRODUCTION

This study concerns the second part of an overall study of the energy systems available for Waskaganish.

The objective is to assist the Cree community of Waskaganish in defining the optimal energy supply scenario to be adopted for the next fifty years.

Data on wood furnaces and mini-hydroelectric power plant are derived from two studies previously realized by ABBDL-TECSULT [1] and its subsidiary COGESULT. [2]

This study is divided into four parts: the energy demand, the available energy systems, the definition of the energy supply scenarios to be studied and a comparative analysis of the latter. An executive summary is presented at the beginning of this report and a bibliography is provided in section 8.

Conclusions and recommendations about the adoption of an energy supply scenario for the next fifty years are presented in section 7.

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(1) Prefeasibility study of mini-hydro potential in the vicinity of Waskaganish.

(2) A firewood demand and supply study for the communities of Eastmain, Wemindji and Waskaganish, 1984, prepared for the Grand Council of the Crees (of Quebec) and the Cree Regional Authority with contributions from Indian and Northern Affairs Canada and the Remote Community Demonstration Program of Energy, Mines and Resources Canada.

3.0 GENERAL APPROACH

3.1 Energy Demand

The energy demand analysis of the houses managed by the Cree Housing Corporation was based on the Firewood Demand and Supply Study for the communities of Eastmain, Wemindji and Waskaganish which was realized by COGESULT in 1984. This group of houses is hereinafter called the Residential Sector.

A detailed energy audit of the other buildings of Waskaganish was specifically performed for this study. These buildings were taken to form the Commercial and Institutional Sector.

For each sector, the energy demand was estimated for the heating and basic needs. This distinction is important since it could be optimal to use one energy system exclusively for the heating needs and another for the basic needs.

The energy demand forecasts for the next 50 years are also expressed by sector for the heating and basic needs based on the Waskaganish population's growth forecasts.

3.2 Energy Systems

The technical description includes a short presentation of the technology involved, the selection criteria used to choose the optimal model and a technical description of the latter.

3.3 Energy supply scenarios

An energy input/output table is presented in order to identify every energy supply scenarios available. A short description of each scenario follows including the reasons why it is or it is not retained for further analysis.

3.4 Comparative Analysis

The comparative analysis of the energy systems includes:

- an economic analysis;
- an evaluation of the social impacts;
- an evaluation of the environmental impacts.

The economic analysis is based on the evaluation of the present worth of the financial outflows. The social impacts are expressed in terms of job creation and possible modifications to people's energy consumption habits.

4.0 ENERGY DEMAND

4.1 Present Situation

4.1.1 Residential Sector

The total heating energy demand for 1983 has been estimated[1] as the following:

44 cedar houses at 30 400 KWh/house[2]	=	1 337 600 KWh
25 white houses at 27 200 KWh/house[2]	=	680 000 KWh
36 model I at 20 720 KWh/house	=	745 920 KWh
24 model II at 19 800 KWh/house	=	475 200 KWh

The total residential heating energy demand is 3 238 720 KWh. The Basic needs are estimated at 28 KWh[3]/house/day or 10 000 KWh/house/year. The Total Residential Basic needs are:

129 houses X 10 000 KWh/house = 1 290 000 KWh

The total energy demand for the residential sector is:

Heating needs	=	3 238 720 KWh
Basic needs	=	1 290 000 KWh
Total	=	4 528 720 KWh

4.1.2 Commercial and Institutional Sector

Those buildings not included in the Residential Sector are regrouped according to the organization to which they belong.

- The Cree School Board (CSB) manages the school-buildings as well as the teachers' residence. Heating is mainly ensured by oil which is distributed by the same team that also provides the maintenance on the furnaces. A few buildings rely on electric heating.

- The Cree Band Council (CBC) is in charge of the public buildings. Heating is provided by oil and electricity.

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(1) A Firewood Supply and Demand Study for the communities of Eastmain, Wemindji and Waskaganish, 1984.
(2) Before any renovations
(3) Department of Indian Affairs, Canada

. The Hudson Bay Company is the major owner of commercial buildings in Waskaganish. They use only oil.

. Four religious missions use various kinds of fuel.

The other buildings such as the garage, warehouse, airport station, etc. have been regrouped together. Heating is mainly provided by oil.

A complete list of the buildings' energy consumption for 1983 is presented in table 4.1. Heating can be provided by oil, wood or electricity. An estimate of the Electrical Basic needs is also included. These figures are derived from on site inspection and information gathered from discussions with the personnel in charge of the buildings. The new school, the community centre, the new clinic and the new doctor's residence have only been added to the figures for 1984 even though some were in operation at the end of 1983.

The heating energy demand is calculated based on the following hypothesis:(1)

- Oil calorific value = 10.6 KWh/litre
- Oil furnaces efficiency = 65%
- Wood calorific value = 4350 KWh
- Wood furnaces efficiency = 60%

The heating demand is:

216 000 litres x 10.6 KWh/litre x .65	=	1 488 240 KWh
53 large cords x 4350 KWh/large cord x.60	=	138 330 KWh
Electric heating	=	165 500 KWh
		1 792 070 KWh

The total energy demand in 1983 for the Commercial and Institutional Sector is:

Heating needs	=	1 792 070 KWh
Basic needs	=	784 000 KWh
Total	=	2 576 070 KWh

(1) Firewood supply and demand study - Cogesult.

Table 4.1

ENERGY DEMAND FROM THE COMMERCIAL AND INSTITUTIONAL SECTOR

TYPE OF BUILDING	No	Area[1] (sq. feet)	Heating Needs Oil (liters)	Oil (KWh)	Wood (large cord)	Wood (K	Electricity	Basic Needs Electricity KWh)
CREE SCHOOL BOARD								
Grey old main school	1		9 600	66 14[illegible]	0	0	0	32 000
Teacher's residence no. 208	1		4 600	31 69[illegible]	0	0	0	10 000
Class building no. 201	1		9 500	65 45[illegible]	0	0	0	14 000
Cree Way Centre	1		3 600	24 80[illegible]	0	0	0	12 000
Classroom trailers	3		9 000	62 0[illegible]	0	0	0	36 000
John Murdock's house	1		3 300	22 7[illegible]	0	0	0	10 000
Teacher's residence no. 205	1		4 400	30 31[illegible]	0	0	0	16 000
Old clinic building	1		4 800	33 0[illegible]	0	0	0	10 000
Band appartments	2		8 800	60 63[illegible]		0	0	20 000
La Salle house	1		2 300	15 847		0	0	10 000
Anglican Mission Church (teachers)	1		3 000	20 670		0	3 000	10 000
French School	1		10 000	68 900	0	0	0	12 000
Model I classroon bldg	3		9 000	62 010	0	0	0	28 000
Mary Bear residence	1		0	0	0	0	28 000	18 000
New school	1		(40 000)	(275 600)	0	0	0	110 000
Teacher's trailers	2		5 000	34 450	0	0	0	16 000
			86 900	598 741	0	0	31 000	345 000
HUDSON BAY COMPANY								
Main store	1		14 000	96 460	0	0	0	98 000
Warehouse	1		7 600	52 364	0	0	0	10 000
Clerks' residence	1		4 500	31 005	0	0	0	8 000
Manager's residence	1		9 000	62 010	0	0	0	10 000
Old warehouse	1		0	0	0	0	0	10 000
			35 100	241 839	0	0	0	127 000

(1) This column was added and left empty at the request of the Client.

CREE BAND COUNCIL

	Area	Heating Needs					Basic Needs
		Oil		Wood	Electricity		Electricity
	(sq. feet)	(liters)	(KWh)	(large cord)	(KWh)	(KWh)	(KWh)
Cree Band Office		1 800	12 402	0	0	62 500	22 000
Public bathroom and lavomatic		6 000	41 340	0	0	0	18 000
Cree Community Centre		(12 000)	(82 680)	0	0	0	(30 000)
Cree lodging		8 000	55 120	0	0	0	26 000
Sewer and water pumping station[1]		12 000	82 680	0	0	0	800
Nurses' residence		6 000	41 340	0	0	0	28 000
New clinic		(8 000)	(55 120)	0	0	0	(24 000)
Doctor's residence		(3 000)	(20 670)	0	0	0	(10 000)
2 trailers [2]		4 000	27 560	0	0	0	14 000
1 trailer [2]		0	0	0	0	16 000	17 000
		37 800	260 442	0	0	78 500	133 000
RELIGIOUS MISSIONS							
Evangelist (house and church)		0	0	7	18 270	6 000	6 000
Anglican church		2 000	13 780	0	0	0	6 000
Catholic mission (house and church)		5 200	35 828	1	2 610	4 000	8 000
Federal house (police station, social centre, 2 apts)		6 000	41 340	0	0	0	16 000
2 houses		6 000	41 340	0	0	0	16 000
Pentecotal church		4 000	27 560	7	18 270	0	12 000
church		0	0	10	26 100	0	6 000
house		0	0	0	0	16 000	400
old church							
		23 200	159 848	25	65 250	26 000	70 400

1. The water in the main line is preheated before to be directed towards the buildings.

2. Presently used as residence by Cree families.

OTHERS

	Area	Heating Needs					Basic Needs
		Oil		Wood	Electricity		Electricity
	(sq. feet)	(liters)	(KWh)	(large cord)	(KWh)	(KWh)	(KWh)
Garage Blackned		2 800	19 292	0	0	0	10 000
Warehouse (W. McCloud)		1 000	6 890	0	0	0	4 000
Warehouse		3 000	20 670	0	0	0	8 000
Airport station		2 500	17 225	0	0	0	6 000
Sodab		800	5 512	0	0	0	2 000
Cree construction's trailers		6 000	41 340	0	0	0	12 000
Very old houses (7)		10 000	68 900	28	73 080	30 000	36 000
Cree housing lodging		7 000	48 230	0	0	0	14 000
City lights: 20 (20 sodium lights - 300 watts)		0	0	0	0	0	17 500
		33 000	227 370	28	73 080	30 000	109 500

TABLE 4.2

SUMMARY OF THE ENERGY DEMAND FROM THE COMMERCIAL AND INSTITUTIONAL SECTOR

	Heating Needs					Basic Needs
	Area (sq. feet)	Oil (l		Wood (large	Electricity	Electricity KWh)
CSB	86 900	598 741	0	0	31 000	345 000
HBC	35 100	241 839	0	0	0	127 000
CBC	37 800	260 442	0	0	78 500	133 000
Missions	23 200	159 848	25	62 250	26 000	70 400
Others	33 000	117 370	28	73 080	30 000	109 000
TOTAL	216 000	1 488 240	53	138 330	165 500	784 400

4.2 Energy Demand Forecasts

4.2.1 Residential Sector

These forecasts have been made for the next fifty years based upon the following assumptions:

- The annual heating energy demand is a function of the renovation or the demolition of old houses, and on the forecasted constructions.
- The population's growth until 1989 is derived from the housing and infrastructure program of the Cree Housing Corporation.
- The annual population's growth rate is assumed to be 3% from 1990 to 1993 and 2.5% from 1994 to 2033 as per the Terms of Reference for this study.
- New houses will be built in groups of fifteen assuming an occupancy rate of 6 persons per house.
- The heating energy demand is derived from the houses heating energy consumption presented in section 4.1.1.
- The heating energy consumption habits are assumed to remain constant for the next fifty years. A significant modification of some of these habits would have a direct impact on the heating energy demand forecasts.
- The house models constructed starting in 1985 are the model "45" and "21"[1]. Each model will be equally constructed. The heating energy consumption of these models is estimated at 14 000 KWh/year and 16 000 KWh/year. These estimates are derived from the plans provided by the Cree Housing Corporation. They are well insulated, semi-detached, compact (the floor area is 24'x26' and 24'x32' respectively) and the basement is inhabited.

Table 4.3 shows the forecast of the residential energy demand for the next fifty years.

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(1) Cogesult, A firewood supply and demand study for the communities of Wemindji, Eastmain and Waskaganish, 1984.

.Table 4.3

RESIDENTIAL ENERGY DEMAND FORECASTS

1984-2033

(Kwh)

	1984	1985	1986	1987	1988	1989	1990	1991	1992
POPULATION	1,010	1,045	1,082	1,120	1,160	1,195	1,231	1,268	1,306
HOUSES	129	144	156	168	183	198	198	198	213
BASIC NEEDS	1,290,000	1,440,000	1,560,000	1,680,000	1,830,000	1,980,000	1,980,000	1,980,000	2,130,000
HEATING NEEDS	2,843,720	3,068,720	3,248,720	3,428,720	3,653,720	3,878,720	3,878,720	3,878,720	4,103,720
TOTAL DEMAND	4,133,720	4,508,720	4,808,720	5,108,720	5,483,720	5,858,720	5,858,720	5,858,720	6,233,720

	1993	1994	1995	1996	1997	1998	1999	2000	2001
POPULATION	1,345	1,378	1,412	1,447	1,483	1,520	1,558	1,596	1,636
HOUSES	213	228	228	228	243	243	258	258	258
BASIC NEEDS	2,130,000	2,280,000	2,280,000	2,280,000	2,430,000	2,430,000	2,580,000	2,580,000	2,580,000
HEATING NEEDS	4,103,720	4,328,720	4,328,720	4,328,720	4,553,720	4,553,720	4,778,720	4,778,720	4,778,720
TOTAL DEMAND	6,233,720	6,608,720	6,608,720	6,608,720	6,983,720	6,983,720	7,358,720	7,358,720	7,358,720

	2002	2003	2004	2005	2006	2007	2008	2009	2010
POPULATION	1,677	1,719	1,762	1,806	1,851	1,897	1,945	1,993	2,043
HOUSES	273	273	288	288	303	303	318	318	333
BASIC NEEDS	2,730,000	2,730,000	2,880,000	2,880,000	3,030,000	3,030,000	3,180,000	3,180,000	3,330,000
HEATING NEEDS	5,003,720	5,003,720	5,228,720	5,228,720	5,453,720	5,453,720	5,678,720	5,678,720	5,903,720
TOTAL DEMAND	7,733,720	7,733,720	8,108,720	8,108,720	8,483,720	8,483,720	8,858,720	8,858,720	9,233,720

(continued)

Table 4.3

RESIDENTIAL ENERGY DEMAND FORECASTS

1984-2033

(Kwh)

	2011	2012	2013	2014	2015	2016	2017	2018	2019
POPULATION	2,094	2,146	2,200	2,255	2,311	2,369	2,429	2,489	2,551
HOUSES	348	348	363	363	378	393	393	408	423
BASIC NEEDS	3,480,000	3,480,000	3,630,000	3,630,000	3,780,000	3,930,000	3,930,000	4,080,000	4,230,000
HEATING NEEDS	6,128,720	6,128,720	6,353,720	6,353,720	6,578,720	6,803,720	6,803,720	7,028,720	7,253,720
TOTAL DEMAND	9,608,720	9,608,720	9,983,720	9,983,720	10,358,720	10,733,720	10,733,720	11,108,720	11,483,720

	2020	2021	2022	2023	2024	2025	2026	2027	2028
POPULATION	2,615	2,681	2,748	2,816	2,887	2,959	3,033	3,109	3,186
HOUSES	423	438	453	468	468	483	498	513	528
BASIC NEEDS	4,230,000	4,380,000	4,530,000	4,680,000	4,680,000	4,830,000	4,980,000	5,130,000	5,280,000
HEATING NEEDS	7,253,720	7,478,720	7,703,720	7,928,720	7,928,720	8,153,720	8,378,720	8,603,720	8,828,720
TOTAL DEMAND	11,483,720	11,858,720	12,233,720	12,608,720	12,608,720	12,983,720	13,358,720	13,733,720	14,108,720

	2029	2030	2031	2032	2033
POPULATION	3,266	3,348	3,431	3,517	3,605
HOUSES	543	543	558	573	588
BASIC NEEDS	5,430,000	5,430,000	5,580,000	5,730,000	5,880,000
HEATING NEEDS	9,053,720	9,053,720	9,278,720	9,503,720	9,728,720
TOTAL DEMAND	14,483,720	14,483,720	14,858,720	15,233,720	15,608,720

4.2.2 Commercial and Institutional Sector

Four new buildings were added in to the figures for 1984 as mentioned in section 4.1.2. Their energy consumption is approximated since no data are available yet.

A new airport is presently being built and should be in operation in 1985. According to the housing and infrastructure program of the Cree Housing Corporation, the Band is planning to build an arena while CHC plans to build a new Band Office and a Community Centre in 1985 and 1986 respectively. The Department of Indian Affairs plans to provide the Band with a fire truck and build a garage for it. There is no further information concerning the construction of commercial and institutional buildings in the next fifty years.

For the purpose of this study, it was assumed that the relationship between the Residential Energy Demand and the Commercial and Institutional Energy Demand will remain stable for the next fifty years as was the case for the Province of Quebec between 1978 and 1982[1] which means the Commercial and Institutional Energy Demand will vary at the same rate as the Residential Energy Demand.

The Residential Energy Demand forecasts show a 2.33% growth over the next fifty years. The same growth is thus applied to the Commercial and Institutional Energy Demand, starting in 1985. The forecasts are shown in table 4.4.

(1) Les statistiques de l'énergie au Québec 1978, 79, 80, 81, 82, Energie et Ressources Québec, Secteur énergie, Direction générale de l'analyse économique et financière.

Table 4.4

COMMERCIAL AND INDUSTRIAL ENERGY DEMAND FORECASTS

1984-2033

(Kwh)

	1984	1985	1986	1987	1988	1989	1990	1991	1992
BASIC NEEDS	930,400	952,078	974,262	996,962	1,020,191	1,043,962	1,068,286	1,093,177	1,118,648
HEATING	2,126,583	2,176,132	2,226,836	2,278,722	2,331,816	2,386,147	2,441,744	2,498,637	2,556,855
TOTAL DEMAND	3,056,983	3,128,211	3,201,098	3,275,684	3,352,007	3,430,109	3,510,030	3,591,814	3,675,503

	1993	1994	1995	1996	1997	1998	1999	2000	2001
BASIC NEEDS	1,144,713	1,171,384	1,198,678	1,226,607	1,255,187	1,284,433	1,314,360	1,344,985	1,376,323
HEATING	2,616,430	2,677,393	2,739,776	2,803,613	2,868,937	2,935,783	3,004,187	3,074,184	3,145,813
TOTAL DEMAND	3,761,143	3,848,777	3,938,454	4,030,220	4,124,124	4,220,216	4,318,547	4,419,169	4,522,136

	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASIC NEEDS	1,408,391	1,441,206	1,474,787	1,509,149	1,544,312	1,580,295	1,617,116	1,654,794	1,693,351
HEATING	3,219,110	3,294,116	3,370,869	3,449,410	3,529,781	3,612,025	3,696,185	3,782,306	3,870,434
TOTAL DEMAND	4,627,501	4,735,322	4,845,655	4,958,559	5,074,093	5,192,320	5,313,301	5,437,101	5,563,785

(continued)

Table 4.4

COMMERCIAL AND INDUSTRIAL ENERGY DEMAND FORECASTS

1984-2033

(Kwh)

	2011	2012	2013	2014	2015	2016	2017	2018	2019
BASIC NEEDS	1,732,806	1,773,181	1,814,496	1,856,773	1,900,036	1,944,307	1,989,610	2,035,967	2,083,405
HEATING	3,960,615	4,052,897	4,147,330	4,243,963	4,342,847	4,444,035	4,547,581	4,653,540	4,761,968
TOTAL DEMAND	5,693,421	5,826,078	5,961,826	4,429,640	4,532,851	4,638,466	4,746,542	4,857,137	4,970,308

	2020	2021	2022	2023	2024	2025	2026	2027	2028
BASIC NEEDS	2,131,949	2,181,623	2,232,455	2,284,471	2,337,699	2,392,168	2,447,905	2,504,942	2,563,307
HEATING	4,872,921	4,986,460	5,102,645	5,221,537	5,343,198	5,467,695	5,595,092	5,725,458	5,858,861
TOTAL DEMAND	5,086,116	5,204,623	5,325,891	5,449,984	5,576,968	5,706,912	5,839,883	5,975,952	6,115,192

	2029	2030	2031	2032	2033
BASIC NEEDS	2,623,032	2,684,148	2,746,689	2,810,687	2,876,176
HEATING	5,995,373	6,135,065	6,278,012	6,424,289	6,573,975
TOTAL DEMAND	6,257,676	6,403,480	6,552,681	6,705,358	6,861,593

Table 4.5

TOTAL ENERGY DEMAND FORECASTS

1984-2033

(Kwh)

	1984	1985	1986	1987	1988	1989	1990	1991	1992
TOTAL BASIC NEEDS	2,220,400	2,392,078	2,534,262	2,676,962	2,850,191	3,023,962	3,048,286	3,073,177	3,248,648
TOTAL HEATING NEEDS	4,970,303	5,244,852	5,475,556	5,707,442	5,985,536	6,264,867	6,320,464	6,377,357	6,660,575
TOTAL NEEDS	7,190,703	7,636,931	8,009,818	8,384,404	8,835,727	9,288,829	9,368,750	9,450,534	9,909,223

	1993	1994	1995	1996	1997	1998	1999	2000	2001
TOTAL BASIC NEEDS	3,274,713	3,451,384	3,478,678	3,506,607	3,685,187	3,714,433	3,894,360	3,924,985	3,956,323
TOTAL HEATING NEEDS	6,720,150	7,006,113	7,068,496	7,132,333	7,422,657	7,489,503	7,782,907	7,852,904	7,924,533
TOTAL NEEDS	9,994,863	10,457,497	10,547,174	10,638,940	11,107,844	11,203,936	11,677,267	11,777,889	11,880,856

	2002	2003	2004	2005	2006	2007	2008	2009	2010
TOTAL BASIC NEEDS	4,138,391	4,171,206	4,354,787	4,389,149	4,574,312	4,610,295	4,797,116	4,834,794	5,023,351
TOTAL HEATING NEEDS	8,322,830	8,297,836	8,599,589	8,678,130	8,983,501	9,065,745	9,374,905	9,461,026	9,774,154
TOTAL NEEDS	12,361,221	12,469,042	12,954,375	13,067,279	13,557,813	13,676,040	14,172,021	14,295,821	14,797,505

(continued)

Table 4.5

TOTAL ENERGY DEMAND FORECASTS

1984-2033

(Kwh)

	2011	2012	2013	2014	2015	2016	2017	2018	2019
TOTAL BASIC NEEDS	5,212,806	5,253,181	5,444,496	5,486,773	5,680,036	5,874,307	5,919,610	6,115,967	6,313,405
TOTAL HEATING NEEDS	10,089,335	10,181,617	10,501,050	10,597,683	10,921,567	11,247,755	11,351,301	11,682,260	12,015,688
TOTAL NEEDS	15,302,141	15,434,798	15,945,546	16,084,456	16,601,603	17,122,063	17,270,911	17,798,227	18,329,093

	2020	2021	2022	2023	2024	2025	2026	2027	2028
TOTAL BASIC NEEDS	6,361,949	6,561,623	6,762,455	6,964,471	7,017,699	7,222,168	7,427,905	7,634,942	7,843,307
TOTAL HEATING NEEDS	12,126,641	12,465,180	12,806,365	13,150,257	13,271,918	13,621,415	13,973,812	14,329,178	14,687,581
TOTAL NEEDS	18,488,590	19,026,804	19,568,820	20,114,728	20,289,618	20,843,583	21,401,718	21,964,119	22,530,888

	2029	2030	2031	2032	2033
TOTAL BASIC NEEDS	8,053,032	8,114,148	8,326,689	8,540,687	8,756,176
TOTAL HEATING NEEDS	15,049,093	15,188,785	15,556,732	15,920,009	16,302,695
TOTAL NEEDS	23,102,124	23,302,933	23,883,421	24,468,696	25,058,871

TABLE 4.6

POTENTIAL PEAK POWER DEMAND

1984 - 2033
(KWh)

	1984	1985	1986	1987	1988	1989	1990	1991	1992
BASIC NEEDS									
RESIDENTIAL	425.70	475.70	514.80	554.40	603.90	653.40	653.40	653.40	703.90
COMM. AND INST.	189.00	193.41	197.93	202.54	207.27	212.11	217.06	222.12	227.31
TOTAL	614.70	669.11	712.73	756.94	811.17	865.51	870.46	875.52	930.21
HEATING NEEDS									
RESIDENTIAL	1287.50	1391.00	1473.80	1556.60	1660.10	1763.60	1763.60	1763.60	1867.10
COMM. AND INST.	983.00	1005.90	1029.33	1053.31	1077.85	1102.96	1128.66	1154.98	1181.86
TOTAL	2270.50	2396.90	2503.13	2609.91	2737.95	2866.56	2892.26	2918.55	3048.96
TOTAL PEAK DEMAND	2885.20	3066.01	3215.86	3366.86	3549.12	3732.07	3762.71	3794.07	3979.16

	1993	1994	1995	1996	1997	1998	1999	2000	2001
BASIC NEEDS									
RESIDENTIAL	703.90	752.40	752.40	752.40	801.90	801.90	851.40	851.40	851.40
COMM. AND INST.	232.61	238.04	243.59	249.27	255.09	261.04	267.13	273.36	279.74
TOTAL	935.51	990.44	995.99	1001.67	1056.99	1062.94	1118.53	1124.76	1131.14
HEATING NEEDS									
RESIDENTIAL	1867.10	1970.60	1970.60	1970.60	2074.10	2074.10	2177.60	2177.60	2177.60
COMM. AND INST.	1209.39	1237.57	1266.40	1295.90	1326.09	1356.99	1388.60	1420.95	1454.05
TOTAL	3076.49	3208.17	3237.00	3266.50	3400.19	3431.09	3566.20	3598.55	3631.65
TOTAL PEAK DEMAND	4012.00	4198.60	4232.99	4268.17	4457.18	4494.03	4684.73	4723.31	4762.79

	2002	2003	2004	2005	2006	2007	2008	2009	2010
BASIC NEEDS									
RESIDENTIAL	900.90	900.90	950.40	950.40	999.90	999.90	1049.40	1049.40	1098.90
COMM. AND INST.	286.26	292.94	299.77	306.77	313.92	321.24	328.74	336.40	344.25
TOTAL	1187.16	1193.84	1250.17	1257.17	1313.82	1321.14	1378.14	1385.80	1443.15
HEATING NEEDS									
RESIDENTIAL	3381.10	3381.10	3384.60	3384.60	3488.10	3488.10	3591.60	3591.60	3695.10
COMM. AND INST.	1487.91	1522.60	1558.07	1594.37	1631.51	1669.52	1708.42	1748.23	1788.95
TOTAL	3769.03	3803.70	3942.67	3978.97	4119.61	4157.62	4300.02	4339.83	4484.05
TOTAL PEAK DEMAND	4956.19	4997.54	5192.84	5236.13	5433.43	5478.77	5678.15	5725.63	5927.20

(continued)

TABLE 4.6

POTENTIAL PEAK POWER DEMAND

1984 - 2033
(KWh)

	2011	2012	2013	2014	2015	2016	2017	2018	2019
BASIC NEEDS									
RESIDENTIAL	1148.40	1148.40	1197.90	1197.90	1247.40	1296.90	1296.90	1346.40	1395.90
COMM. AND INST.	352.20	360.49	368.90	377.50	386.31	395.33	404.53	413.97	423.62
TOTAL	1500.60	1508.89	1566.80	1575.40	1633.71	1692.22	1701.43	1760.37	1819.52
HEATING NEEDS									
RESIDENTIAL	2798.60	2798.60	2902.10	2902.10	3005.60	3109.10	3109.10	3212.60	3316.10
COMM. AND INST.	1830.63	1873.28	1916.92	1961.58	2007.28	2054.05	2101.91	2150.88	2200.99
TOTAL	4629.23	4671.88	4819.03	4863.68	5012.88	5163.15	5211.01	5363.48	5517.09
TOTAL PEAK DEMAND	6129.91	6180.77	6385.82	6439.09	6646.59	6855.37	6912.44	7123.84	7336.61

	2020	2021	2022	2023	2024	2025	2026	2027	2028
BASIC NEEDS									
RESIDENTIAL	1395.90	1445.40	1494.90	1544.40	1544.40	1593.90	1643.40	1692.90	1742.40
COMM. AND INST.	433.50	443.61	453.95	464.53	475.36	486.45	497.79	509.40	521.27
TOTAL	1829.40	1889.01	1948.85	2008.93	2019.76	2080.35	2141.19	2202.30	2263.67
HEATING NEEDS									
RESIDENTIAL	3316.10	3419.60	3523.10	3626.60	3626.60	3730.10	3833.60	3937.10	4040.60
COMM. AND INST.	2252.27	2304.74	2358.44	2413.39	2469.61	2527.15	2586.03	2646.28	2707.94
TOTAL	5568.37	5724.34	5881.54	6039.99	6096.21	6257.25	6419.63	6583.38	6748.54
TOTAL PEAK DEMAND	7397.76	7613.35	7830.39	8048.92	8115.98	8337.60	8560.82	8785.68	9012.21

	2029	2030	2031	2032	2033
BASIC NEEDS					
RESIDENTIAL	1791.90	1791.90	1841.40	1890.90	1940.40
COMM. AND INST.	533.43	545.86	558.59	571.61	584.94
TOTAL	2325.33	2337.76	2399.99	2462.51	2525.34
HEATING NEEDS					
RESIDENTIAL	4144.10	4144.10	4247.60	4351.10	4454.60
COMM. AND INST.	2771.03	2835.59	2901.65	2969.26	3038.44
TOTAL	6915.13	6979.69	7149.25	7320.36	7493.04
TOTAL PEAK DEMAND	9240.45	9317.45	9549.24	9782.87	10018.37

4.3 Electric Power Demand

The peak power demand which occurs during the winter defines the size of the energy systems required. This power demand has to be evaluated for the various buildings (including houses) for the selection of appropriate furnaces and at the community level, for the selection of the centralized energy systems such as the diesel generators or the mini-hydroelectric power plant. This peak power demand is defined for the basic and heating needs.

4.3.1 Basic Needs

The basic needs include electricity consumed by the freezer, the refrigerator, the stove, the washing machine, the dryer, the television and sound system, the lighting, small electric appliances and the water heater. This consumption of electricity remains fairly stable throughout the year.

The average maximum power demand required to fulfill the basic needs of a typical house is estimated at 3.3 KW[1] (see appendix 5).

In view of the buildings heterogeneity in the commercial and institutional sector, the power demand was derived from the annual energy demand. The following methodology is applied:

$$\frac{\text{annual energy demand}}{\text{8760 hours}} = \text{hourly energy demand}$$

$$\text{Utilization factor} = \frac{\text{hourly energy demand}}{\text{peak power demand}}$$

For the basic needs, the utilization factor is estimated at 56.1%.[1] The annual energy demand in 1984 will be 930 400 KWh. The peak power demand will be:

$$\frac{(930\ 400\ \text{KWh}/8760\ \text{h})}{.561} = 189\ \text{KW}$$

The peak power demand in the residential sector will be:

129 houses X 3.3 KW/house = 426 KW

The total peak power demand for the basic needs is 615 KW. The peak power demand for the next fifty years is presented in Table 4.6.

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(1) Derived from the Waskaganish electricity consumption in 1983 as provided by the Department of Indian Affairs, Canada.

4.3.2 Heating Needs

The heating needs vary considerably according to the seasons. The yearly peak demand usually occurs in January. For the residential sector, the peak demand is derived from the heating energy consumption calculations:

G X T = Maximum power demand

G = Global heat loss coefficient
T = Maximum temperature variance

For Waskaganish, the average lower minimum is -39°C.

T = 18°C [(1)] - (-39° C) = 57°C

Model 1 peak demand is:

.169 KW/°C X 57° C = 9.7 KW

Model 11 peak demand is:

.162 KW/°C X 57° C = 9.2 KW

Renovated white house peak demand is:

.194 KW/°C X 57° C = 11.1 KW

Renovated cedar house peak demand is:

.1747 KW/°C X 57° C = 10.0 KW

The total peak power demand coming from the residential sector in 1984 is:

36 model 1 X 9.7 KW	=	349 KW
24 model 11 X 9.2 KW	=	221 KW
25 white houses X 11.1 KW	=	277 KW
44 cedar houses X 10.0 KW	=	440 KW
Total		1 287 KW

The new house models have an average peak demand of 6.9 KW.

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(1) 18°C is the reference temperature used in the degree-days calculations. This reference temperature is widely accepted and used by energy specialists. This does not represent the average room temperature which is slightly higher.

The calculation of the commercial and institutional heating power demand is based on the methodology used to estimate the basic needs power demand. The utilization factor for heating is set equal to the heating utilization factor of the residential sector: 24.7%. The heating and basic peak power demand for the next fifty years is presented in table 4.6.

5.0 AVAILABLE ENERGY SYSTEMS

In accordance with the Terms of Reference, the energy systems studied are:

- Diesel generator
- Oil furnace
- Wood furnace
- Thermoelectric generator
- Gasifier
- Windmill
- Mini-hydroelectric power plant
- Interconnection with the Hydro-Quebec grid.

5.1 Diesel Generators

This is a technology widely used in remote communities. It has been proven reliable and easy to operate. It requires specialized personnel for the maintenance.

In Waskaganish, four diesel generators are presently in use, two 800 KW units and two 250 KW units. Their life expectancy is 15 years but a major overhaul is necessary after 20 000 hours of operation (2 1/2 years).

Their energetic efficiency is approximately 30%.(1) In 1983, the production of 3 017 358 KWh required the consumption of 950 000 litres of diesel. The fuel is transported in the summer and stocked in a reservoir of 1 000 000 litres.

Normal maintenance, occasional repairs and periodic overhauls make the presence of stand-by units of equal power to those in operation necessary.

5.2 Oil Furnaces

In 1983, 62% of the heating needs (3 120 000 KWh or 452 700 litres) in Waskaganish were fulfilled by oil furnaces. Only a few buildings are not equipped with an oil furnace. Every house is equipped with a central warm-air heating system using an oil burner. The oil-furnace heating power is usually 35 KW and their life expectancy is around 20 years. Their energetic efficiency varies from 60% to 70% depending on the maintenance provided. The forecasted oil consumption is based on a 65% efficiency level.

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(1) Department of Indian Affairs, Canada

This is a very reliable technology requiring a minimum maintenance. The maintenance can be easily provided by specialized personnel who have attended a short training program on this matter.

5.3 Wood Furnaces

Most of the houses are equipped with an add-on wood furnace which operates in conjunction with the oil furnace system. There was only eleven houses in 1984 which were only equipped with an oil furnace. In 1983, 425 large cords of wood provided 1 100 000 KWh used for residential heating.

The efficiency of these furnaces is about 65% when careful maintenance is provided. The chimneys must be inspected and cleaned regularly and dry wood must be used. Wood furnaces provide efficient, economical, reliable and safe heating energy when these prescriptions are respected.

This is again a very simple technology which can be easily operated. The main characteristic of this system is its manual feeding. It requires the continuous presence of somebody in the house during the winter period to feed the furnace when the house temperature starts going down.

The firewood demand and supply study for the communities of Eastmain, Wemindji and Waskaganish confirmed the availability of firewood in sufficient quantity and at a competitive price.

5.4 Thermoelectric Generators

The thermoelectric generator produces electricity using a conventional technology. Wood combustion produces heat that is used to create steam which is piped under pressure to turbines to generate electricity. The equipment consists of a conventional steam boiler and an associated steam turbine. This kind of system is reliable and has been used for many years.

The maximum energetic efficiency is about 28% for the electricity production but may reach 73% when the generated thermic energy is also recovered. Recovery of the thermal energy may be profitable when the power plant is located near large buildings (such as an hospital or an important industry) and thus does not necessitate expensive substructure works.

When this is not the case, as in Waskaganish, the cost of the substructure works including pipelines and heat exchangers is prohibitive making the recovery of thermal energy from the steam unrealistic.

This technology has few users in Canada. It is usually located near large wood processing industries and the energy sold to a few large consumers located in the vicinity. The boiler must be fed with wood chips, a by-product of the wood industries. Finally it must be emphasized that scale economies may be significant when larger turbines are used.

This energy system is consequently discarded and will not be considered as an available energy supply system for Waskaganish.

5.5 Gasifiers

This energy system uses two distinct technologies: the gasifier, which is the installation that will produce a gas of low calorific value, and a generator set which will use the gas as fuel to generate electricity.

There are three technologies used to produce gas from wood:

a) fixed bed gasifier
b) washed down bed gasifier
c) fluidized bed gasifier

The most sophisticated technology uses pure oxygen feeding in conjunction with a fluidized bed (as in St-Juste de Bretonnière). This technology allows a large production of a richer gas which is similar to natural gas.

The low power gasifier is however more suited for small scale operation in remote communities.

Many European, American, and Canadian companies manufacture such low power gasifiers:

- Westwood Polygas (British Columbia)
- B.C. Research (British Columbia)
- Mellinger Gazodyne (New Brunswick)
- Halayon (New Hampshire)
- Brosolar (Oregon)
- BNK (British Columbia)
- Duvant (France)
- Imbert (West Germany)
- Wastsila (Finland)

The gasifier produces a low calorific gas which does not ignite spontaneously when compressed thus the diesel engine must have a driven-ignition. The efficiency of these generators is 30%.

This is a fairly new technology which is still in development. The expertise is not very widespread and no remote community in Canada is presently using such a system.

As with the thermo-electric generators, the gasifier consumes wood chips.

This energy system does not presently represent a true alternative for Waskaganish. It will not be considered for the elaboration of the energy supply scenarios.

5.6 Windmills

This section will only deal with already fully tested low power windmills. The medium and high power windmills (over 100 KW) are still at an experimental level.

The windmills energetic performance is a function of two variables:

- air engine technical characteristics
- wind rate at the installation site

The technical characteristics of the mills may vary significantly from one windmill to another. Their efficiency and power is a function of the wind velocity. Windmills start to generate electricity at a certain wind speed and gain power progressively up to a certain limit. Beyond this limit, their power is more or less stabilized by regulation systems (air break, variable pitch, etc.). This stabilization process prevents possible dammage from overrunning. The vanes are designed to run optimally at this limit speed. The optimal power of various models may be consequently reached at different wind speed. It is therefore important to choose a windmill that reaches its nominal power at a wind speed close to the average wind speed registered at the installation site. The overall windmill performance can only be determined if the distribution of wind speed is known.

In order to know the exact wind potential of a site, daily information must be recorded for a minimum of one year. The following information is required:

- wind speeds and their duration
- maximum speed
- yearly average speed
- calm periods and their duration

All this can be achieved by installing an anenometer coupled with a registering device.

No wind information is presently available in Waskaganish. For the purpose of this study, the wind data for Poste de la Baleine are used since the geographical characteristics are similar and this is the closest observation site available. The average wind speed in Poste de la Baleine is 4 m/s. A 4 m/s average wind speed is the minimum speed acceptable for windmill implementation.

Windmills are presently used as auxiliary systems due to the random and variable character of wind speed. In order to meet the peak power demand, the windmill average power must be considered rather than the nominal power which is rarely reached. This makes the windmill an expensive energy system when used alone as the main system.

Cogesult calculated that with an average wind speed of 4 m/s, 4 391 units of 1.8 KW would be necessary in 1984. This does not take into account the accumulation stand-by system which would be made of batteries costing in 1984 1.8$ millions.

Windmills cannot be considered as a valid energy supply system for Waskaganish. No further analysis will be made on this option.

5.7 Mini-Hydroelectric Power Plant

In 1983, the Waskaganish Band Council gave ABBDL-TECSULT the mandate to undertake a prefeasibility study of the mini-hydro potential in the vicinity of Waskaganish. The report was presented in October 1983.

This technology is well-known and reliable, requiring little maintenance once in operation. The technical information is detailed in the above-mentioned study. A transmission line of 69 KV would bring the energy to the community. The electric distribution network would be up-graded to support the increased load.

Two capacities were studied in this report, a 1.0 MW to meet the basic needs for the next thirty years and a 5.7 MW to meet the total energy demand for the same period.

For the purpose of this study, the Tecsult engineers prepared a preliminary estimate for a 2.5 MW power plant at the same site to meet the basic needs for fifty years and for a 10.0 MW power plant to meet the total energy demand over the same period.

5.8 Interconnection with the Hydro-Quebec Grid

This is an interconnection with the provincial grid owned and managed by Hydro-Quebec. A 69 KV transmission line would give access to the electricity produced by the La Grande hydroelectric installations. No major technical problems should be encountered since Hydro-Quebec has acquired a large experience in the transportation of electricity in these areas.

The transmission line would start from the Nemiscau station and would be 206km in length. The lie of the corridor would follow the winter road between the LG2 road and Waskaganish. The lie of the section between the Nemiscau station and the LG-2 road is not precisely defined but would be as straight as possible. H-frame type of support would be used, requiring a corridor of 40 to 80 feet in width.

6.0 ENERGY SUPPLY SCENARIOS

6.1 Energy demand and supply

The energy demand was estimated in section 4. A presentation of the energy supply systems followed in section 5. Six of these alternatives were retained as valid options for the community. These are:

- diesel generators
- oil furnaces
- wood furnaces
- 2.5 MW mini-hydro
- 10.0 MW mini-hydro
- 69 KV transmission line

Some of these systems can support the total load while others can only meet heating or basic needs. Many combinations of energy supply systems are then possible to meet the total energy demand.

6.2 Energy supply scenarios

The table 6.1 presents the energy demand and the energy that can be supplied by the retained energy systems.

Wood furnaces can only supply heating energy for the residential sector. The "Firewood supply and demand study for the communities of Wemindji, Eastmain and Waskaganish" prepared by COGESULT clearly demonstrated that there was enough wood to meet the total heating needs of the residential sector but that people do not want to rely completely on wood heating because of the problems related to the feeding of the furnace during the night and when the house is empty. An heating scenario including 75% wood and 25% oil was then recommended. This recommendation is respected in table 6.1; energy supplied by wood furnaces represents 75% of the residential heating needs.

Oil furnaces can supply the total heating energy demand. The diesel generators produce electricity that can be used for basic needs or heating. The 2.5 MW mini-hydro is designed only to meet the peak power demand for basic needs while the 10 MW power plant is designed to meet the total power demand. The transmission line can provide enough energy to meet the total demand but electricity could be used only for basic or heating needs.

Each possible combination of these energy systems is discussed hereafter.

ENERGY INPUT-OUTPUT TABLE

TABLE 6.1

(millions of KWh)

	1985			1990			1995			2000		
	BASIC	HEATING	TOTAL	BASIC	HEATING	TOTAL	BASIC	HEATING	TOTAL	BASIC	HEATING	TOTAL
ENERGY DEMAND	2.4	5.2	7.6	3	6.3	9.4	3.5	7.1	10.5	3.9	7.9	11.8
WOOD FURNACES		2.3 (1)			2.9			3.2			3.6	
OIL FURNACES		5.2			6.3			7.1			7.9	
DIESEL GENERATORS	2.4	5.2	7.6	3	6.3	9.4	3.5	7.1	10.5	3.9	7.9	11.8
MINI-HYDRO 2.5 MW (2)	2.4			3			3.5			3.9		
MINI-HYDRO 10 MW (2)			7.6			9.4			10.5			11.8
TRANSMISSION LINE	2.4	5.2	7.6	3	6.3	9.4	3.5	7.1	10.5	3.9	7.9	11.8

(1). This represents the maximum energy potential available from wood furnaces. All the other energy systems that can provide heating energy can meet the total demand which is 5.2 millions of KWh in 1984.

(2). 2.5 and 10 MW are the maximum power capacities of the power plants. The maximum quantity of energy that can be produced is the nominal power multiplied by 8760 hours/year. For the 2.5 MW power plant, this is 2500 KW x 8760 hours = 21.9 millions of KWh. The size of the power plant is however determined with regard to the power demand expected.

ENERGY INPUT-OUTPUT TABLE

(CONTINUED)

TABLE 6.1

(millions of KWh)

	2005			2010			2015			2020		
	BASIC	HEATING	TOTAL	BASIC	HEATING	TOTAL	BASIC	HEATING	TOTAL	BASIC	HEATING	TOTAL
ENERGY DEMAND	4.4	8.7	13.1	5	9.8	14.8	5.7	10.9	16.6	6.4	12.1	18.5
WOOD FURNACES		3.9			4.4			5			5.6	
OIL FURNACES		8.7			9.8			10.9			12.1	
DIESEL GENERATORS	4.4	8.7	13.1	5	9.8	14.8	5.7	10.9	16.6	6.4	12.1	18.5
MINI-HYDRO 2.5 MW (2)	4.4			5			5.7			6.4		
MINI-HYDRO 10 MW (2)			13.1			14.8			16.6			18.5
TRANSMISSION LINE	4.4	8.7	13.1	5	9.8	14.8	5.7	10.9	16.6	6.4	12.1	18.5

ENERGY INPUT-OUTPUT TABLE

(CONTINUED)

TABLE 6.1

(Millions of KWh)

	2025			2030			2033		
	BASIC	HEATING	TOTAL	BASIC	HEATING	TOTAL	BASIC	HEATING	TOTAL
ENERGY DEMAND	7.2	13.6	20.8	8.1	15.2	23.3	8.8	16.3	25.1
WOOD FURNACES		6.2			6.9			7.3	
OIL FURNACES		13.6			15.2			16.3	
DIESEL GENERATORS	7.2	13.6	20.8	8.1	15.2	23.3	8.8	16.3	25.1
MINI-HYDRO 2.5 MW (2)	7.2			8.1			8.8		
MINI-HYDRO 10 MW (2)			20.8			23.3			25.1
TRANSMISSION LINE	7.2	13.6	20.8	8.1	15.2	23.3	8.8	16.3	25.1

6.2.1 Scenarios including utilization of electricity produced by diesel generators for heating

Four scenarios can be elaborated based on the utilization of electricity produced by the diesel generators for heating purposes. They are:

- Heating energy = Wood furnaces - diesel generators
  Basic energy = diesel generators

- Heating energy = diesel generators
  Basic energy = transmission line

- Heating and basic energy = Diesel generators

- Heating energy = diesel generators
  Basic energy = 2.5 MW mini-hydro

These four scenarios can not be retained because of the low energetic efficiency of the diesel generators (about 30%). It is more optimal to use oil furnaces for heating since it uses the same type of fuel and has a 60 to 65% efficiency.

6.2.2 Heating energy = Wood furnaces - oil furnaces
Basic energy = diesel generators

This scenario is very close to the present situation. The only difference lies in the wood contribution which was around 34% of the residential heating needs in 1983-1984 and is 75% in this scenario. This will be scenario #1.

6.2.3 Heating energy = Wood furnaces - transmission line
Basic energy = transmission line

The electricity provided by the transmission line would satisfy the total demand except 75% of the residential heating needs. This scenario takes into account the will of the community to favor the exploitation of local ressources instead of importing all the energy from Hydro-Quebec. This will be scenario #2.

6.2.4 Heating energy = wood furnaces - oil furnaces
Basic energy = 2.5 MW mini-hydro

The mini-hydro power plant provides electricity for basic needs while wood and oil furnaces fulfill the heating needs. This is the scenario #3.

6.2.5 Scenarios including utilization of oil furnaces for the total residential heating needs

Three scenarios can be elaborated using only oil furnaces for residential heating. They are:

- Heating energy = Oil furnaces
  Basic energy = diesel generators

- Heating energy = Oil furnaces
  Basic energy = 2.5 MW mini-hydro

- Heating energy = Oil furnaces
  Basic energy = transmission line

These three scenarios will not be retained because of the conclusions of the Firewood study previously mentioned. This study demonstrated that wood heating was significantly cheaper than oil heating in Waskaganish.

6.2.6 Heating energy = wood furnaces - oil furnaces
Basic energy = transmission line

Since the transmission line is constructed for the basic needs, the marginal cost of heating with the electricity provided by the trasmission line is much lower than the heating costs associated with oil furnaces. This scenario is not retained.

6.2.7 Scenarios including utilization of the electricity provided by the transmission line for heating only

Two scenarios can be elaborated where a transmission line provides only electricity for heating. They are:

- Heating energy = transmission line
  Basic energy = 2.5 MW mini-hydro

- Heating energy = transmission line
  Basic energy = diesel generators

The capital investments remain the same whether or not the transmission line provides heating and basic energy or only heating energy. It is therefore not optimal to generate basic electricity with additional equipment which will require important capital investments.

6.2.8 Heating and basic energy = 10 MW mini-hydro

This mini-hydro power plant can meet the total energy demand for fifty years. This is scenario #4.

6.2.9 Heating and basic energy = transmission line

The transmission line can provide enough energy to meet the total demand for fifty years. This is the scenario #5.

6.3 Summary

Five energy supply scenarios can be considered as true alternatives for Waskaganish. They are presented in table 6.2 and figure 6.1.

Table 6.2

Energy supply scenarios

energy needs / scenario	Heating	Basic
#1	wood furnace oil furnace	diesel generator
#2	wood furnace transmission line	transmission line
#3	wood furnace oil furnace	2.5 MW mini-hydro
#4	10 MW mini-hydro	10 MW mini-hydro
#5	transmission line	transmission line

Two scenarios include a single energy system, one scenario includes two energy systems and two scenarios incorporate three energy systems.

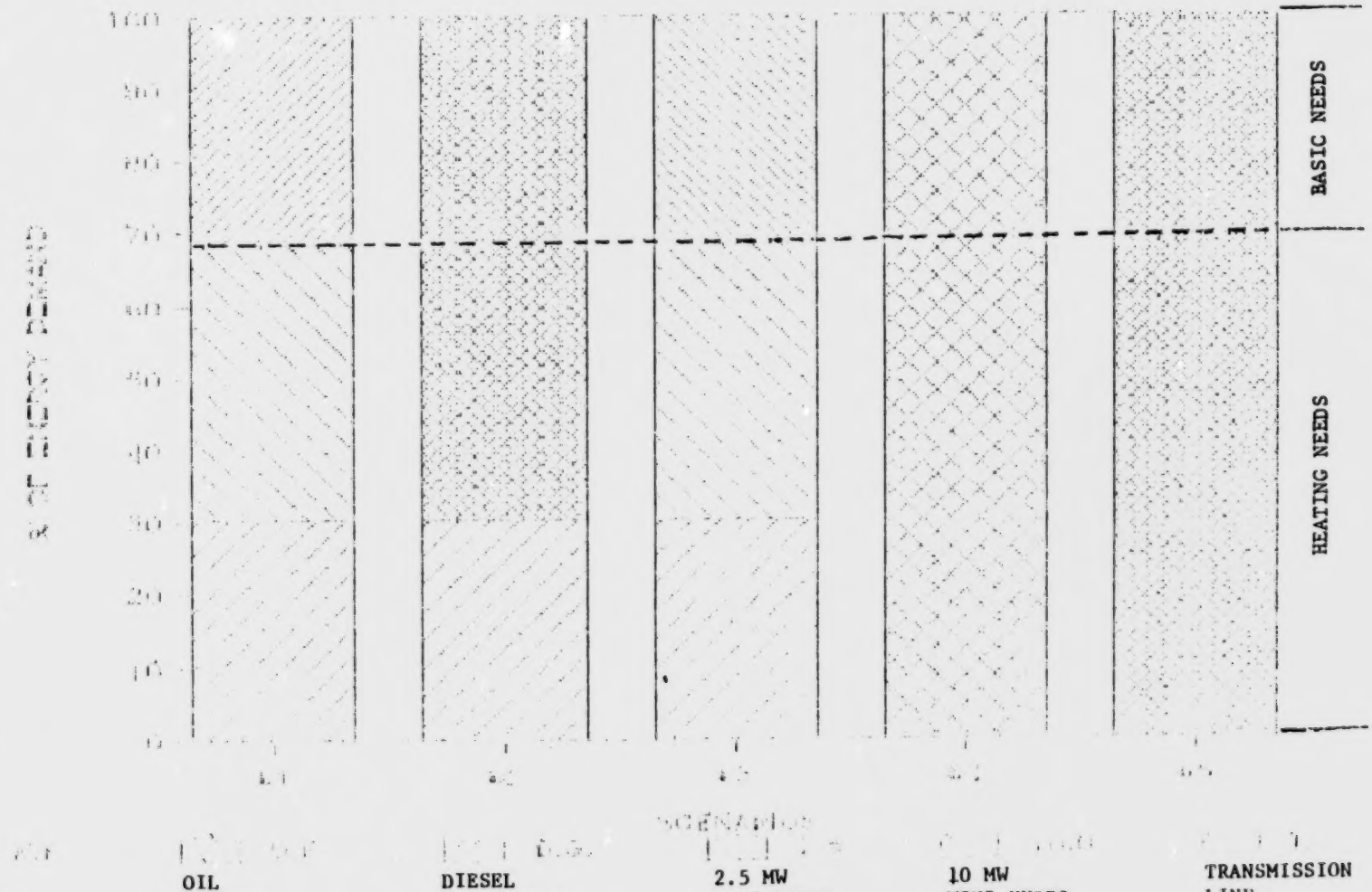
ENERGY SUPPLY SCENARIOS
BASIC NEEDS
HEATING NEEDS
WOOD FURNACE
OIL FURNACE
DIESEL GENERATORS
2.5 MW MINI-HYDRO
10 MW MINI-HYDRO
TRANSMISSION LINE

FIGURE 6.1

7.0 COMPARATIVE ANALYSIS

In this section the five energy supply scenarios will be compared with regard to the following decision elements:

- economic analysis
- social impacts
- environmental considerations

7.1 Economic Analysis

The economic analysis seeks to compare the total cost of each scenario on an equitable basis. Since the cashflows associated with each scenario are not equally distributed over fifty years, it is necessary to use the well-known technique of discounted cashflows. This technique is based on the fact that people prefer having one dollar today rather than wait until the next year. Therefore today's dollar has more value than next year's dollar regardless of the inflation impact. This "time effect" is taken into account by discounting the moneys spent in the future, i.e. giving them less importance than moneys spent today.

The discount rate that has been used is the real interest rate, that is to say the cost of money without the effects of inflation.

The Quebec government uses a 4% real interest rate as it is stated in the decree #300-84 (see appendix 6). This economic analysis will also adopt a 4% discount rate.

The sum of all discounted costs over the life of the scenario related to the adoption of an energy scenario is called the Present Worth. The scenario with the lowest Present Worth represents the most advantageous option for the next fifty years from an economic standpoint.

In order to show the impact of discounting the cashflows, a straight sum of all costs related to a scenario will also be presented, giving the opportunity to compare the present worth of a scenario with the "absolute" value of the moneys spent for this same scenario. (i.e. if money always had the same value).

All costs are expressed in 1984 dollars and are discounted to this same year. Since all costs are assumed to vary in nominal terms at the same rate as inflation, they all remain constant in real terms for the next fifty years.

There is however, one exception: the oil price. The large fluctuations of oil prices during the last ten years justified the utilization of a different price growth forecast. Many oil prices forecasts are presently available. Some important variations may be found when comparing each other but it is widely accepted that no rapid

price escalation is expected for a long period. Cogesult adopted, for the purpose of this study, the more recent Economic Council of Canada forecasts of the general price index and oil price variations. The resulting oil prices forecast is in appendix 1.

The investment costs considered are those for construction, engineering, equipment, and conversion.

The operation expenses include the cost of the energy and the operation and maintenance costs. Detailed calculations are presented in appendix II.

7.1.1 Scenario #1

Heating energy is provided by oil and wood furnaces while diesel generators produce the electricity required for the basic needs.

7.1.1.1 Diesel Generators

Unit cost

An 800 KW unit costs 450 000 $ while a 250 KW costs 100 000$, this including installation and contingencies.

Life expectancy

15 years. It is assumed that the present equipment still has a 10 year life expectancy.

Investment schedule

It is assumed that for one generator in use there is a similar generator kept on stand-by. The investment schedule supposes that a generator is continually in operation for one year and serves as stand-by unit the year after.

Two additional 800 KW generators will accordingly be required in 1997 and 1998 to meet the basic demand. The two present 800 KW generators will be replaced in 2002 and 2003. Four additional 800 KW generators are also added in 2015, 2016, 2031 and 2032 and two are replaced in 2031 and 2032. The salvage value of the generators not fully depreciated at the end of the project will be 1 710 000$.

Operation and maintenance costs

In 1983-1984, operation and maintenance excluding the fuel totaled up to 122 500$ or 0.04$/KWh. Diesel cost is found in appendix 1.

A complete overhaul is necessary after 2 1/2 years of operation. The overhaul cost is estimated at 150 000$ for the 800 KW unit and 35 000$ for the 250 KW unit.

Other characteristics

A generator is in operation during a full year and then on stand-by for the following year.

7.1.1.2 Oil Furnaces

Unit cost

In order to make fair comparisons, no equipement located inside the houses or other buildings are considered. This study covers only the external generating systems.

Life expectancy

Not required

Investment schedule

Not required

Operation and maintenance costs

The furnaces efficiency is 65% and the calorific value of oil is 10.6 KWh/litre. The oil prices are found in appendix 1. The maintenance costs are estimated at 0.005$/KWh.

Other characteristics

Every building is presently equipped with an oil furnace.

A 1 000 000 litres reservoir is presently used to stock oil during the summer. The population growth will eventually make necessary the addition of a second reservoir. Cost of a new reservoir of 900 000 litres is 250 000$, transportation and installation included.

7.1.1.3 Wood Furnaces

Unit cost

As for the oil furnaces, no investment cost is considered except for the conversions required by the choice of this option. The white and green houses will be equipped with a wood furnace connected to its warm-air system. The total cost including transportation and installation is 1 450$.

Life expectancy

Not required

Investment schedule

Not required

Operation and maintenance costs

A large cord of wood costs 110$ as estimated in the "Firewood demand and supply study for the communities of Eastmain, Wemindji and Waskaganish". The calorific value of wood is 4 982 KWh/cord as estimated in the above mentioned study. The wood furnace efficiency is 65% and the maintenance cost is 0.005$/KWh.

Other characteristics

This wood furnace option is only valid for the Residential sector because of the manual feeding which requires the continous presence of somebody.

7.1.1.4 Present Worth

The present worth of this scenario is:

Heating, wood furnaces(1)	=	3 541 500$
Heating, oil furnaces (2)	=	10 624 100$
Basic, diesel generators	=	27 191 400$
Scenario #1 Present worth	=	41 357 000$
With no discount rate	=	118 345 500$

7.1.2 Scenario #2

In this scenario, firewood is used to fulfill 75% of the residential heating needs. The basic energy demand and the balance of the heating demand is met by the transmission line.

7.1.2.1 Wood furnaces

See section 7.1.1.3

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(1) 75% of residential heating
(2) 25% of residential heating
100% of commercial and institutional heating

7.1.2.2 Transmission line

Unit cost

The investment costs are derived from a preliminary study made by Hydro-Quebec. The construction costs are estimated at 24 000 000$.

To this must be added the modification to the distribution network and the conversion cost of the heating systems.

The conversion costs

Electric heating implies the conversion of the majority of the present heating systems. The conversion costs are the following:

Heating systems smaller than 20 KW

electrical entry	2,000$
Transformation of ducts, furnace and controls	1,200$
Total	3,200$

Heating systems between 20 and 50 KW

Electrical entry 400 A - 220 V	3,500$
Transformations	
20 KW to 30 KW	1,400$
30 KW to 50 KW	2,000$

Total

20 KW to 30 KW	4,900$
30 KW to 50 KW	5,500$

The new school heating system

Electrical entry 400 A - 600 V 3 phases with 600 V transformer	10,000$
Transformation	5,000$
Total	15,000$

In 1984, there are 129 houses and 34 Commercial and Institutional buildings requiring less than 20 KW of heating power. Six buildings need heating power of between 20 KW and 30 KW and three between 30 KW and 50 KW.

The total conversion cost for Waskaganish is:

(129 + 34)	X 3,200$	=	521,600$
6	X 4,900$	=	29,400$
3	X 5,500$	=	16,500$
1	X15,000$	=	15,000$
Total			582,500$

Life expectancy

It is assumed to be 50 years.

Investment schedule

All the investments will be done during the first year.

Operation and maintenance costs

The cost of energy is the normalized cost of Hydro-Quebec. For the residential demand, there is a monthly fee of 7.74$ plus 0.0306$/KWh for the first 900 KWh and 0.0362$/KWh for the additional KWh.

For the Commercial and Institutional sector, the buildings requiring less than 35 KW pay a monthly fee of 7.74$ plus 0.0492$/KWh for the first 10,260 KWh and 0.0297$/KWh for the additional KWh. For the buildings requiring between 35 and 100 KW, it is 7.74$ plus 0.0591$/KWh for the first 10,260 KWh and 0.0297$/KWh for the additional KWh. For the buildings requiring more than 100 KW, there is a monthly fee of 3.66$/KW plus 0.0485$/KWh for the first 120 hours and 0.0297$/KWh for the additional 78,000 KWh. The balance is billed at 0.0206$/KWh.

The maintenance is assumed by Quebec-Hydro.

7.1.2.3 Present Worth

The Present Worth of this scenario is:

Heating needs , wood furnaces	= 3 541 500$
Balance of heating needs and Basic needs, transmission line	= 33 996 300$
Scenario #2 Present Worth	= 37 537 800$
With no discount rate	= 60 251 200$

7.1.3 Scenario #3

As in scenario #1, the heating energy is provided by oil and wood furnaces. Electricity for basic needs is however produced by a 2.5 MW mini-hydroelectric power plant.

7.1.3.1 2.5 MW mini-hydro

The site, the layout and the type of equipment have already been identified in "the prefeasibility study of mini-hydro potential in the vicinity of Rupert House that was prepared by ABBDL-TECSULT. The cost estimates were however made for a 5.7 MW and a 1.0 MW power plants. The power required for the basic needs in 50 years will be 2.5 MW.

The ABBDL-TECSULT engineers accordingly revised the cost estimates for a 2.5 MW power plant (presented next page).

During the construction and start-up period which is estimated at two and a half years, the energy will be provided by diesel generators.ç

The proportion of oil and wood used for residential heating is assumed to be 75% wood - 25% oil as in scenario #1.

Two layouts can be considered. The first one includes two 850 KW turbines and two 460 KW turbines for a total power of 2620 KW. A 850 KW and a 460 KW are installed at the beginning of the project, a second 850 KW is installed in the twenty-third year and a second 460 KW in the thirty-third year.

The second layout incorporates three 850 KW units. Two are installed at the beginning of the project, the third one comes only at the thirty-first year.

Using the discounted cashflow technique, it turns out that the second layout was cheaper by 500 000$. This layout is also more optimal from a technical standpoint as it is preferable to combine turbines of the same size to minimize the maintenance costs. The second layout is consequently adopted and the construction costs are based on it.

	Investment costs
	2.5 MW
Access : Permanent road	1 500 000
winter road	1 040 000
Diversion works	730 000
Civil works	1 800 000
Turbines and generators (2 x 850KW)	2 400 000
Transmission line	1 950 000
Total construction costs	9 420 000
Indirect costs	2 539 000
Contingency	1 695 000
Total	13 654 000

Life expectancy

The life expectancy of a mini-hydro power plant is assumed to be 50 years.

Investment schedule

A third 850 KW turbine will be added in 2014 to bring the total power to 2.55 MW.

Operation and maintenance costs

The operation and maintenance costs are approximately 20$/installed KW. It is also supposed that the diesel generators will supply 1% of the total annual energy demand as stand-by units.(1) For the diesel generators, see section 7.1.1.1.

7.1.3.2 Oil furnaces

See section 7.1.1.2

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(1) Normal maintenance does not require that the turbines stop at the same time.

7.1.3.3 Wood furnaces

See section 7.1.1.3

7.1.3.4 Present Worth

The present worth of this scenario is:

Heating, wood furnaces	=	3 541 500$
Heating, oil furnaces	=	10 624 100$
Basic, 2.5 MW mini-hydro	=	15 871 800$
Scenario #3 Present Worth	=	30 037 400$
With no discount rate	=	58 874 900$

7.1.4 Scenario #4

The total energy demand is satisfied by a 10 MW mini-hydroelectric power plant.

7.1.4.1 10 MW mini-hydro

This 10 MW mini-hydro is an upgraded version of the 5.7 MW power plant presented by ABBDL-TECSULT in its "Prefeasibility study of mini-hydro potential in the vicinity of Rupert House". The construction period is two years and a 6 month start-up period is needed as for the 2.5 MW power plant. Two 2 MW turbines are installed at the beginning, one other 2 MW unit is added in 1992 and a 4 MW turbine is finally added in 2010 to bring the total power to 10 MW.

As for the 2.5 MW power plant, the basic energy comes from the diesel generators during the first two and a half years while the residential heating energy is provided by wood and oil furnaces in the same proportions as presently, i.e. 34% wood, 66% oil and commercial and institutional heating needs are fulfilled by oil furnaces.

	Investment Costs
	10 MW
Access: Permanent road	1,500,000$
Winter road	1,040,000$
Diversion works	9,705,000$
Civil works	5,392,000$
Turbines and generators (2 X 2000 KW)	3,536,000$
Transmission line	2,705,000$
Network up-grade	130,000$
Total	24,008,000$

Indirect costs	6,960,000$
Contingency	4,640,000$
Total	35,608,000$

To this must be added the conversion cost of the heating systems as presented in section 7.1.2.2.

Life expectancy

The life expectancy is fifty years.

Investment schedule

A third 2 MW turbine is added in 1992 and a 4 MW turbine will be installed in 2010.

Operation and maintenance costs

The O & M costs are approximately 20$/installed KW. The diesel generators will supply 1% of the total energy demand as stand-by units to be used when all the turbines must be stopped at the same time.

7.1.4.2 Present Worth

The scenario #4 Present Worth = 43 563 000$
with no discount rate = 56 011 700$

7.1.5 Scenario #5

This scenario is very similar to the scenario #2. The transmission line however provides all the energy needed for the basic and heating needs.

As for the scenario #4, there is only one energy supply source. The characteristics of the transmission line are found in section 7.1.2.2.

7.1.5.1. Present worth

Scenario #5 Present Worth = 36 908 100$
With no discount factor = 58 555 600$

7.1.6 Reference scenario

The reference scenario is very similar to scenario #1. The difference lies in the proportion of wood used for residential heating. As mentioned in the "Firewood study", the present consumption of wood

fulfills 34% of the residential heating needs in Waskaganish. The reference scenario includes this ratio of 34% instead of the 75% ratio found in the scenario #1.

The cost evaluation is identical to the one presented in scenario #1.

7.1.6.1 Present worth

The Present Worth of the reference scenario is:

Oil and wood heating	=	17 207 300$
Diesel generators - basic needs	=	27 191 400$
Reference scenario Present Worth	=	44 398 700$
With no discount rate	=	167 182 000$

7.1.7 Sensitivity analysis

The selection of a discount rate has an important impact on the results of an economic analysis. Table 7.1 presents the Present Worth of the five scenarios when using discount rates of 2%, 6% and 8%. They are compared with the results obtained when using 4%.

With a discount rate of 2%, the scenario #3 (2.5 MW mini-hydro) remains the cheapest scenario. The scenario #1 with the diesel generators is the most expensive scenario.

At 6%, the scenario #3 is still the best alternative but the scenario #1 becomes the second cheapest alternative. The 10 MW mini-hydro represents the more expensive scenario.

A discount rate of 8% makes the scenario #1 (diesel generators) cheaper than all the other scenarios including the 2.5 MW mini-hydro scenario. This can be explained by the fact that no major investments are needed at the beginning of the project in the scenario #1.

7.2 Social and environmental impacts

The first part of this section presents the social and environmental impacts associated with each energy system.

This will be followed by a comparison of these impacts regrouped inside the five scenarios.

7.2.1.1 Diesel Generators

This is the system in use in Waskaganish. It employs imported fuel and creates a few jobs. There will be no significant social impact associated with the decision to continue to generate electricity with diesel generators.

TABLE 7.1

SENSITIVITY ANALYSIS

VARIATIONS OF THE DISCOUNT RATE

DISCOUNT RATES	2%	4%	6%	8%
SCENARIO #1	66931	41357	27773	20034
SCENARIO #2	45220	27538	18299	13153
SCENARIO #3	39723	30037	24764	21260
SCENARIO #4	48014	43563	40852	39017
SCENARIO #5	44233	36908	32862	30439

The operation of diesel generators involves the exhaust of certain noxious gases which may contribute to air pollution. Population density in the James Bay region is however low and the consequent air pollution may be considered as in significant.

7.2.1.2 Oil Furnaces

Imported fuel is used which will have a very small impact on job creation. It is the heating system presently in use in most of the buildings. The only impact expected is the dependence on oil supply which can be less reliable during international crisis.

The environmental impacts are similar to the one mentioned for the diesel generators.

7.2.1.3 Wood Furnaces

Every house is equipped with either a wood stove or a wood furnace, furthermore wood fulfilled 34% of the residential heating needs (1 100 000 KWh or 425 large cords) in 1983-84.[1] Wood is a local source of energy which is, to a certain extent, renewable (long cycle period). The generalized adoption of wood for residential heating would provide the opportunity to create a local organization in charge of the wood harvesting and its distribution and consequently create new seasonal jobs.

The wood harvesting operations require the following personnel:

- 18 wood cutters
- 6 persons in charge of the loading and transportation
- 3 foremen
- 1 supervisor

These are average figures based on a thirty year operation period. The duration of these jobs would be 40 days, the exception being the supervisor who should be hired for 80 days.

These figures are derived from the "Firewood demand and supply study for the communities of Eastmain, Wemindji and Waskaganish" made by COGESULT in 1984.

This heating system requires more attention from the user for two reasons:

- The manual feeding of the furnace;
- The obligation to keep the chimney in proper condition so as to avoid fire hazards.

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(1) A Firewood Demand and Supply Study for the communities of Estmain, Wemindji and Waskaganish, Cogesult, 1984.

The "Firewood study" indicated that there were no major environmental impact expected from wood harvesting.

However, harvesting should be performed carefully so as to:

a) maximize the natural reafforestation;

b) minimize the erosion along the water courses;

c) minimize the impact on the hunting and trapping activities;

d) minimize the risk of forest fires.

7.2.1.4 Mini-Hydroelectric Power Plant

This is an energy system which utilizes a renewable energy source. It requires a limited personnel for its maintenance but will create temporary jobs during the construction period. The mini-dam should not disturb living patterns of the community since it will be located 35 km outside the village.

This project would be a run-of-the-river diversion plant taking full advantage of the natural channel existing on the left bank of the proposed site. The access road is already existing for the first twenty kilometers, this road connecting a sand and gravel borrow area to the village. An additional section of 9 kilometers would follow the existing lie of the winter road, minimizing again the impact on the environment. A last section of 3 kilometers comprised between the winter road and the site would be entirely new.

The access road will consequently have no additional significant impact on the environment since the road is already existing. The impact of the transmission line will also be very limited since it will follow the access road.

To summarize, the hunting and trapping activities and the navigation routes would not be affected if this site was adopted. This was confirmed by Messrs. Gordon Blackned and Rupert Erless who accompanied the ABBDL engineers during their visit to this site in July 1983 (see account of this visit of Z. Aziz and A. Stoïan presented to Bill Namagoose in appendix 3).

7.2.1.5 Interconnection with the Hydro-Quebec Grid

This alternative has minor impact on the community. There would be no major equipment installed in the village and no maintenance required in Waskaganish. Temporary jobs can however be available during its construction.

The construction of a transmission line involves the creation of a corridor through 206 km. of lands and forests. Since the lie of the corridor follows the winter road between Waskaganish and the LG2 road, no significant impact on the environment is expected on this section of the lie.

A positive impact will come from the recovery of the wood cut during the deforestation of the corridor. The volume cannot be presently estimated since no forestry map covers this area (except for the Waskaganish surroundings).

7.2.2 Comparative analysis

Table 7.2 presents the social and environmental impacts associated with each scenario. No scenario can be discarded because of a significant negative impact on the environment.

On the social side, the scenario #3 generates the largest number of jobs in the community. Wood harvesting creates between 25 and 30 seasonal jobs while the construction of the mini-hydro would induce important economic activity during the construction period. This scenario favours the utilization of local resources for energy generation. Wood heating however requires more attention from the user.

Scenario #1 and #2 generate about the same level of economic activity but the interconnection with Quebec-Hydro grid ensures a more reliable supply of electricity.

It also decreases the needs for imported fuel that has to be stocked during the summer season.

Scenario #4 and #5 have a very similar impact, that is jobs creation on a short period of time at the beginning of the project.

COMPARATIVE ANALYSIS

TABLE 7.2

	SOCIAL IMPACTS	ENVIRONMENTAL IMPACTS
SCENARIO #1	- DIESEL GENERATORS AND OIL FURNACES CONSUME IMPORTED FUEL - DIESEL GENERATORS AND OIL FURNACES CREATE ONLY A FEW JOBS IN THE COMMUNITY - WOOD HARVESTING CREATES MANY SEASONAL JOBS - WOOD FURNACES REQUIRE MANUAL FEEDING - WOOD FURNACES REQUIRE MORE MAINTENANCE TO AVOID FIRE HAZARDS	- DIESEL GENERATORS AND OIL FURNACES HAVE PRACTICALLY NO IMPACT ON THE ENVIRONMENT - CAREFUL WOOD HARVESTING IS REQUIRED TO AVOID: -OVEREXPLOITATION -EROSION OF THE WATER COURSE -DISTURBING HUNTING AND TRAPPING ACTIVITIES -FOREST FIRES
SCENARIO #2	- CONSTRUCTION OF THE TRANSMISSION LINE WILL CREATE TEMPORARY JOBS - WOOD HARVESTING CREATES MANY SEASONAL JOBS - WOOD FURNACES REQUIRE MANUAL FEEDING - WOOD FURNACES REQUIRE MORE MAINTENANCE TO AVOID FIRE HAZARDS	- THE TRANSMISSION LINE REQUIRES THE CREATION OF A DEDICATED CORRIDOR OF 206 KM. IN LENGTH WHICH WILL FOLLOW THE WINTER ROAD IN THE CREE TERRITORIES - CAREFUL WOOD HARVESTING IS REQUIRED TO AVOID: -OVEREXPLOITATION -EROSION OF THE WATER COURSE -DISTURBING HUNTING AND TRAPPING ACTIVITIES -FOREST FIRES
SCENARIO #3	- MINI-HYDRO CREATES MANY JOBS DURING THE CONSTRUCTION PERIOD WHICH IS ESTIMATED AT 2.5 YEARS - OIL FURNACES CREATE ONLY A FEW JOBS IN THE COMMUNITY - WOOD HARVESTING CREATES MANY SEASONAL JOBS - WOOD FURNACES REQUIRE MANUAL FEEDING - WOOD FURNACES REQUIRE MORE MAINTENANCE TO AVOID FIRE HAZARDS	- THE MINI-HYDRO HAS NO SIGNIFICANT IMPACT - OIL FURNACES HAVE PRACTICALLY NO IMPACT ON THE ENVIRONMENT - CAREFUL WOOD HARVESTING IS REQUIRED TO AVOID: -OVEREXPLOITATION -EROSION OF THE WATER COURSE -DISTURBING HUNTING AND TRAPPING ACTIVITIES -FOREST FIRES
SCENARIO #4	- MINI-HYDRO CREATES MANY JOBS DURING THE CONSTRUCTION PERIOD WHICH IS ESTIMATED AT 2.5 YEARS	- THE MINI-HYDRO HAS NO SIGNIFICANT IMPACT
SCENARIO #5	- CONSTRUCTION OF THE TRANSMISSION LINE WILL CREATE TEMPORARY JOBS	- THE TRANSMISSION LINE REQUIRES THE CREATION OF A DEDICATED CORRIDOR OF 206 KM. IN LENGTH WHICH WILL FOLLOW THE WINTER ROAD IN THE CREE TERRITORIES

8.0 CONCLUSIONS

The figure 8.1 shows the Present Worth of the five energy supply scenarios. The scenario having the lowest Present Worth is the scenario #3 which includes wood heating for 75% of the residential needs, oil heating for the remainder and a 2.5 MW mini-hydroelectric power plant to produce electricity for the basic needs. The second cheapest scenario is the scenario #5 which is the construction of a transmission line between Nemiscau ad Waskaganish to meet the total energy demand for fifty years. The difference between these two scenarios Present Worth is 6 871 000$.

These two scenarios have no significant impact on the environment. The wood harvesting implied by the scenario #3 must be performed carefully so as not to deteriorate the forest capital. The study prepared by Cogesult on the Firewood demand and supply in Waskaganish was realized for a thirty year period. The forest potential looks sufficient for fifty years but this should be confirmed by wood specialists.

From a social standpoint, the scenario #3 (2.5 MW mini-hydro) is again the most interesting scenario. This is the alternative generating the higher level of economic activity in the community. This scenario also favours the greater utilization of local resources (wood and water) to produce the required energy.

Wood heating however requires more attention in order to have safe and comfortable heating.

8.1 Recommendations

Cogesult recommends the adoption of the scenario #3 as the best energy supply scenario presently available to the Cree community of Waskaganish. This scenario includes:

- wood furnaces for residential heating
- oil furnaces for residential, commercial and institutionnal heating
- 2.5 MW mini-hydroelectric power plant for the total basic needs.

75% of the residential heating needs are fulfilled by wood while the balance of the community heating needs are fulfilled by oil.

Cogesult also recommends a study on the possible benefits associated with the management of the energy surplus temporarily generated by the mini-hydro.

These eventual benefits would reduce the cost of this energy supply scenario. A preliminary estimate of the annual energy surplus generated by the mini-hydro is presented in Appendix 7.

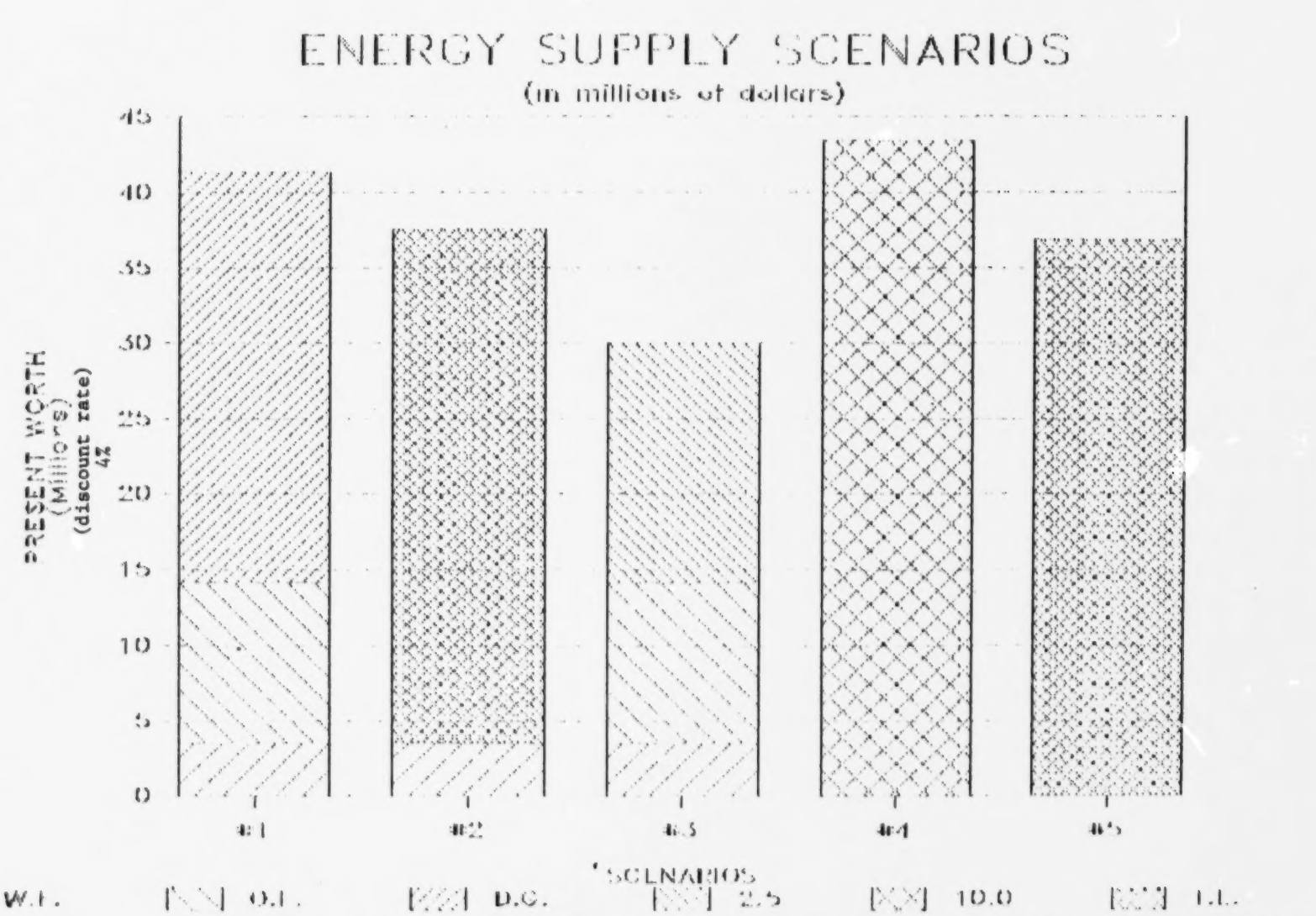
ENERGY SUPPLY SCENARIOS
(in millions of dollars)
PRESENT WORTH
(Millions)
(discount rate)
4%
45
40
35
30
25
20
15
10
5
0
S1
S2
S3
S4
S5
SCENARIOS
W.F.
O.F.
D.G.
2.5
10.0
T.L.
WOOD FURNACES
OIL FURNACES
DIESEL GENARATORS
2.5 MW MINI-HYDRO
10 MW MINI-HYDRO
TRANSMISSION LINE

FIGURE 8.1

It was assumed in this study that Hydro-Quebec would not participate into the financing of the transmission line. The Cree community will however have to validate this assumption. A participation of Hydro-Quebec in the financing of the transmission line would proportionnally lower its costs Present Worth.

Cogesult recommends that the Cree community discuss with Hydro-Quebec on this matter before making any final decision about the adoption of an energy supply scenario for Waskaganish.

9.0 BIBLIOGRAPHY

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10.0 GLOSSARY

Basic electricity: Total electricity consumption except electricity used for heating.

Capital investment: Investment in production means, including construction, land, engineering, equipment, vehicles, furnitures, etc.

Life cycle: Usual useful life of equipment.

Present worth: This is the value which makes people indifferent between having this value today or a corresponding value in the future. The difference comes from the opportunity cost of the money.

Discount rate: Used to calculate the present worth of a cash flow. It represents the cost of lending money.

APPENDIX 1

OIL PRICES FORECASTS

Appendix 1

Oil

Present cost

SODAB has the responsibility to purchase, manage and distribute the heating oil to the three communities. This organization buys once a year heating oil in bulk, supervise the transportation and manage the storage and the distribution.

Transportation costs represent half of the selling prices in the James Bay region. In 1983, SODAB bought its oil in Toronto at 0.31$/litre. To this price was added transportation, storage and administration costs giving selling prices of 0.674$/litre.

Oil prices forecast

All costs are expressed in 1984 dollars. Price variations are therefore expressed in real terms as a function of the variations of the general price index. For example, in 1984, the Economic Council of Canada forecasts a heating oil price increase of 5.1% and a general price increase of 5.4%. This means the heating oil price in constant dollars will decrease by 0.3%.

The most recent general price index forecast from the Economic Council of Canada is:

5.8% in 1985
6.3% in 1986
6.5% in 1987

COGESULT assumes the general price increase will be constant after 1987 at 6.5%.

The price variations of heating oil bought in Toronto is based on the Economic Council of Canada's forecast for 1985 to 1993.

ECONOMIC COUNCIL OF CANADA
HEATING OIL PRICE FORECAST

YEAR	INCREASE (%)
1984	5.1%
1985	5.6%
1986	6.3%
1987	5.0%
1988	5.3%
1989	6.2%
1990	5.4%
1991	5.6%
1992	5.6%
1993	5.4%

COGESULT assumes the oil price will increase at a rate of 6.5% per year between 1994 and 2004 and at a rate of 8.5% for the following thirty years. These forecasts take into account the gradual decrease of the world petroleum reserves.

Heating oil prices in James Bay include important transportation costs which represent approximately 50% of the selling prices. It is assumed that transportation costs will vary according to the general price index variations. For example, a price increase of the heating oil in Toronto that would be 2% higher than the general price increase will lead to a selling price increase of 1% in the Cree communities.

Oil price in Waskaganish (OPW) = Oil Price in Toronto (OPT) + Transportation (TR)

$$\Delta OPW = (.5 \times \Delta OPT) + (.5 \times \Delta TR)$$

if $\Delta OPT = 2\%$
$\Delta TR = 0\%$

$$\Delta OPW = (.5 \times 2\%) + (.5 \times 0\%)$$

$$\Delta OPW = 1.0\%$$

Table 1.3.1 shows the variation of the heating oil selling price in Waskaganish when expressed in constant dollars.

Oil prices forecast

Table 1.3.1

Years	Price variations (%)	Selling price ($/litre)
		Waskaganish
(1)		
1984	-	.674
1985	-.35	.672
1986	0	.672
1987	-.75	.667
1988	-.06	.663
1989	-.015	.662
1990	-.55	.658
1991	-.45	.655
1992	-.45	.652
1993	-.55	.648
1994-2004	0	.648
2005-2033	1	.655 to .874

(1) Selling price in July 1984.

APPENDIX 2

ECONOMIC ANALYSIS WORKSHEETS

DIESEL, BASIC NEEDS
13-FEB-85

12:52:33

COGESULT, EXPERTS-CONSEILS, MONTREAL
PAGE 1

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	1	2	3	4	5	6	7	8	9	10	11	12
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	192.5	192.5	0.0	0.0	192.5	192.5	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	192.5	192.5	0.0	0.0	192.5	192.5	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	470.5	505.4	535.5	561.4	594.3	629.6	630.7	633.1	666.0	667.4	703.4	709.0
MAINTENANCE COSTS	88.8	95.7	101.3	107.1	114.0	120.9	121.9	122.9	129.9	130.9	138.1	139.1
TOTAL	559.3	601.1	636.8	668.5	708.3	750.5	752.6	756.0	795.9	798.3	841.5	848.1
TOTAL COST	559.3	601.1	636.8	668.5	900.8	943.0	752.6	756.0	988.4	990.8	841.5	848.1

PRESENT VALUE = 27191.4

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	13	14	15	16	17	18	19	20	21	22	23	24
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	450.0	642.5	192.5	0.0	157.5	607.5	450.0	0.0	157.5	157.5	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	450.0	642.5	192.5	0.0	157.5	607.5	450.0	0.0	157.5	157.5	0.0
OPERATION EXPENSES												
COST OF ENERGY	714.6	751.0	757.0	793.7	799.9	806.3	843.4	850.1	887.5	903.5	951.0	968.0
MAINTENANCE COSTS	140.2	147.4	148.6	155.8	157.0	158.2	165.5	166.8	174.1	175.6	182.9	184.4
TOTAL	854.8	898.4	905.6	949.5	956.9	964.5	1008.9	1016.9	1061.6	1079.1	1133.9	1152.4
TOTAL COST	854.8	1348.4	1548.1	1142.0	956.9	1122.0	1616.4	1466.9	1061.6	1236.6	1291.4	1152.4

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	25	26	27	28	29	30	31	32	33	34	35	36
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	112.2	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	157.5	157.5	0.0	157.5	315.0	157.5	0.0	607.5	607.5	0.0	157.5	315.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	157.5	157.5	0.0	157.5	315.0	157.5	0.0	607.5	719.7	0.0	157.5	315.0
OPERATION EXPENSES												
COST OF ENERGY	1017.3	1035.6	1086.7	1139.0	1159.3	1213.5	1235.2	1291.5	1349.0	1373.0	1432.7	1493.8
MAINTENANCE COSTS	191.9	193.4	200.9	208.5	210.1	217.7	219.5	227.2	234.9	236.8	244.6	252.5
TOTAL	1209.2	1229.0	1287.6	1347.5	1369.4	1431.2	1454.7	1518.7	1583.9	1609.8	1677.3	1746.3
TOTAL COST	1366.7	1386.5	1287.6	1505.0	1684.4	1588.7	1454.7	2126.2	2303.6	1609.8	1834.8	2061.3

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	37	38	39	40	41	42	43	44	45	46	47	48
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	157.5	157.5	315.0	315.0	157.5	157.5	157.5	0.0	157.5	315.0	157.5	900.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	157.5	157.5	315.0	315.0	157.5	157.5	157.5	0.0	157.5	315.0	157.5	900.0
OPERATION EXPENSES												
COST OF ENERGY	1520.3	1583.7	1648.5	1714.7	1745.1	1813.9	1884.3	1956.1	2029.6	2104.7	2141.9	2220.0
MAINTENANCE COSTS	254.5	262.4	270.5	276.6	280.7	288.9	297.1	305.4	313.7	322.1	324.6	333.1
TOTAL	1774.8	1846.1	1919.0	1991.4	2025.8	2102.8	2181.4	2261.5	2343.3	2426.8	2466.5	2553.1
TOTAL COST	1932.3	2003.6	2234.0	2306.3	2183.3	2260.3	2338.9	2261.5	2500.8	2741.8	2624.0	3453.1

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS	
	49	50
LAND	0.0	0.0
CONSTRUCTION	0.0	0.0
ENGINEERING	0.0	0.0 (1)
EQUIPMENT	1057.5	-1395.0
VEHICLES	0.0	0.0
CONVERSION	0.0	0.0
INTEREST DURING CONST.	0.0	0.0
TOTAL	1057.5	-1395.0
OPERATION EXPENSES		
COST OF ENERGY	2299.8	2381.4
MAINTENANCE COSTS	341.6	350.2
TOTAL	2641.4	2731.6
TOTAL COST	3698.9	1336.6

(1) Residual value of generators (- 1 710 000$)
plus two overhaul (315 000$).

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	1	2	3	4	5	6	7	8	9	10	11	12
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	100.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	100.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	78.4	84.6	89.7	94.6	100.8	107.0	107.0	107.0	113.2	113.2	119.4	119.4
MAINTENANCE COSTS	10.6	11.5	12.1	12.8	13.7	14.5	14.5	14.5	15.3	15.3	16.2	16.2
TOTAL	89.0	96.1	101.8	107.4	114.5	121.5	121.5	121.5	128.5	128.5	135.6	135.6
TOTAL COST	189.1	96.1	101.8	107.4	114.5	121.5	121.5	121.5	128.5	128.5	135.6	135.6

PRESENT VALUE = 3541.5

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	13	14	15	16	17	18	19	20	21	22	23	24
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	119.4	125.6	125.6	131.8	131.8	131.8	138.0	138.0	144.3	144.3	150.4	150.4
MAINTENANCE COSTS	16.2	17.8	17.8	17.9	17.9	17.9	18.7	18.7	19.6	19.6	20.4	20.4
TOTAL	135.6	143.4	143.4	149.7	149.7	149.7	156.7	156.7	163.9	163.9	170.8	170.8
TOTAL COST	135.6	143.4	143.4	149.7	149.7	149.7	156.7	156.7	163.9	163.9	170.8	170.8

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	25	26	27	28	29	30	31	32	33	34	35	36
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	156.7	156.7	162.9	169.1	169.1	175.3	175.3	181.5	187.8	187.8	193.9	200.1
MAINTENANCE COSTS	21.3	21.3	22.1	23.0	22.9	23.8	23.8	24.6	25.5	25.5	26.3	27.2
TOTAL	178.0	178.0	185.0	192.1	192.0	199.1	199.1	206.1	213.3	213.3	220.2	227.3
TOTAL COST	178.0	178.0	185.0	192.1	192.0	199.1	199.1	206.1	213.3	213.3	220.2	227.3

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	37	38	39	40	41	42	43	44	45	46	47	48
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	200.1	206.4	212.6	218.7	218.7	225.0	231.2	237.4	243.6	249.8	249.8	256.0
MAINTENANCE COSTS	27.2	28.0	28.8	29.7	29.7	30.5	31.4	32.2	33.1	33.9	33.9	34.8
TOTAL	227.3	234.4	241.4	248.4	248.4	255.5	262.6	269.6	276.7	283.7	283.7	290.8
TOTAL COST	227.3	234.4	241.4	248.4	248.4	255.5	262.6	269.6	276.7	283.7	283.7	290.8

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

YEARS

	49	50
LAND	0.0	0.0
CONSTRUCTION	0.0	0.0
ENGINEERING	0.0	0.0
EQUIPMENT	0.0	0.0
VEHICLES	0.0	0.0
CONVERSION	0.0	0.0
INTEREST DURING CONST.	0.0	0.0
TOTAL	0.0	0.0
OPERATION EXPENSES		
COST OF ENERGY	262.2	268.4
MAINTENANCE COSTS	35.6	36.4
TOTAL	297.8	304.8
TOTAL COST	297.8	304.8

OIL FURNACES, 25% RES. HEATING
13-FEB-85

13:20:15

COGESULT, EXPERTS-CONSEILS, MONTREAL
PAGE 1

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	1	2	3	4	5	6	7	8	9	10	11	12
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	69.5	74.8	79.2	82.9	87.9	93.2	92.6	92.2	97.1	96.5	101.8	101.8
MAINTENANCE COSTS	3.5	3.8	4.0	4.2	4.5	4.8	4.8	4.8	5.1	5.1	5.4	5.4
TOTAL	73.0	78.6	83.2	87.1	92.4	98.0	97.4	97.0	102.2	101.6	107.2	107.2
TOTAL COST	73.0	78.6	83.2	87.1	92.4	98.0	97.4	97.0	102.2	101.6	107.2	107.2

PRESENT VALUE = 2921.1

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	13	14	15	16	17	18	19	20	21	22	23	24
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	101.8	107.1	107.1	112.4	112.4	112.4	117.7	117.7	123.0	124.2	130.8	132.1
MAINTENANCE COSTS	5.4	5.6	5.6	5.9	5.9	5.9	6.2	6.2	6.5	6.5	6.8	6.8
TOTAL	107.2	112.7	112.7	118.3	118.3	118.3	123.9	123.9	129.5	130.7	137.6	138.9
TOTAL COST	107.2	112.7	112.7	118.3	118.3	118.3	123.9	123.9	129.5	130.7	137.6	138.9

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	25	26	27	28	29	30	31	32	33	34	35	36
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	139.0	140.3	147.4	154.5	156.1	163.4	165.0	172.6	180.3	182.1	190.0	198.0
MAINTENANCE COSTS	7.1	7.1	7.3	7.6	7.6	7.9	7.9	8.2	8.5	8.5	8.7	9.0
TOTAL	146.1	147.4	154.7	162.1	163.7	171.3	172.9	180.8	188.8	190.6	198.7	207.0
TOTAL COST	146.1	147.4	154.7	162.1	163.7	171.3	172.9	180.8	188.8	190.6	198.7	207.0

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	37	38	39	40	41	42	43	44	45	46	47	48
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	200.0	208.3	216.7	225.2	227.5	236.3	245.2	254.3	263.6	273.0	275.7	285.4
MAINTENANCE COSTS	9.0	9.3	9.6	9.9	9.9	10.1	10.4	10.7	11.0	11.3	11.3	11.6
TOTAL	209.0	217.6	226.3	235.1	237.4	246.4	255.6	265.0	274.6	284.3	287.0	297.0
TOTAL COST	209.0	217.6	226.3	235.1	237.4	246.4	255.6	265.0	274.6	284.3	287.0	297.0

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS 49	50
LAND	0.0	0.0
CONSTRUCTION	0.0	0.0
ENGINEERING	0.0	0.0
EQUIPMENT	0.0	0.0
VEHICLES	0.0	0.0
CONVERSION	0.0	0.0
INTEREST DURING CONST.	0.0	0.0
TOTAL	0.0	0.0
OPERATION EXPENSES		
COST OF ENERGY	295.3	305.3
MAINTENANCE COSTS	11.8	12.2
TOTAL	307.1	317.5
TOTAL COST	307.1	317.5

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	1	2	3	4	5	6	7	8	9	10	11	12
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	208.3	212.4	217.1	220.8	224.1	229.1	232.9	237.8	241.9	246.2	252.1	257.9
MAINTENANCE COSTS	10.6	10.9	11.1	11.4	11.7	11.9	12.2	12.5	12.8	13.1	13.4	13.7
TOTAL	218.9	223.3	228.2	232.2	235.8	241.0	245.1	250.3	254.7	259.3	265.5	271.6
TOTAL COST	218.9	223.3	228.2	232.2	235.8	241.0	245.1	250.3	254.7	259.3	265.5	271.6

PRESENT VALUE = 7703.0

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	13	14	15	16	17	18	19	20	21	22	23	24
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	263.7	269.6	276.0	282.5	289.0	296.1	302.6	309.7	316.9	324.2	330.9	350.0
MAINTENANCE COSTS	14.0	14.3	14.7	15.0	15.4	15.7	16.1	16.5	16.7	17.2	17.6	18.1
TOTAL	277.7	283.9	290.7	297.5	304.4	311.8	318.7	326.2	333.6	345.4	356.5	368.1
TOTAL COST	277.7	283.9	290.7	297.5	304.4	311.8	318.7	326.2	333.6	345.4	356.5	368.1

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	25	26	27	28	29	30	31	32	33	34	35	36
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	112.2
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	112.2
OPERATION EXPENSES												
COST OF ENERGY	361.8	374.4	386.7	399.6	412.8	426.8	441.1	455.5	470.9	487.1	502.9	520.3
MAINTENANCE COSTS	18.5	18.9	19.4	19.8	20.3	20.7	21.2	21.7	22.2	22.7	23.3	23.8
TOTAL	380.3	393.3	406.1	419.4	433.1	447.5	462.3	477.2	493.1	509.8	526.2	544.1
TOTAL COST	380.3	393.3	406.1	419.4	433.1	447.5	462.3	477.2	493.1	509.8	526.2	656.3

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	37	38	39	40	41	42	43	44	45	46	47	48
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	537.3	556.0	574.3	593.5	613.8	634.4	655.3	677.3	699.5	723.0	747.6	772.5
MAINTENANCE COSTS	24.4	24.9	25.5	26.1	26.7	27.3	27.9	28.6	29.3	29.9	30.7	31.4
TOTAL	561.7	580.9	599.8	619.6	640.5	661.7	683.2	705.9	728.8	752.9	778.3	803.9
TOTAL COST	561.7	580.9	599.8	619.6	640.5	661.7	683.2	705.9	728.8	752.9	778.3	803.9

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS 49	50
LAND	0.0	0.0
CONSTRUCTION	0.0	0.0
ENGINEERING	0.0	0.0
EQUIPMENT	0.0	0.0
VEHICLES	0.0	0.0
CONVERSION	0.0	0.0
INTEREST DURING CONST.	0.0	0.0
TOTAL	0.0	0.0
OPERATION EXPENSES		
COST OF ENERGY	798.7	829.2
MAINTENANCE COSTS	32.1	32.9
TOTAL	830.8	858.1
TOTAL COST	830.8	858.1

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

YEARS

	1	2	3	4	5	6	7	8	9	10	11	12
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	24000.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	130.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	582.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	24712.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	748.3	257.3	267.3	277.4	288.9	300.6	305.8	311.2	323.2	328.8	341.0	346.9
MAINTENANCE COSTS	102.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	851.2	257.3	267.3	277.4	288.9	300.6	305.8	311.2	323.2	328.8	341.0	346.9
TOTAL COST	25563.7	257.3	267.3	277.4	288.9	300.6	305.8	311.2	323.2	328.8	341.0	346.9

PRESENT VALUE = 33996.3

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	13	14	15	16	17	18	19	20	21	22	23	24
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	352.9	365.6	371.9	384.9	391.5	398.2	411.6	418.7	432.5	439.9	454.0	461.7
MAINTENANCE COSTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	352.9	365.6	371.9	384.9	391.5	398.2	411.6	418.7	432.5	439.9	454.0	461.7
TOTAL COST	352.9	365.6	371.9	384.9	391.5	398.2	411.6	418.7	432.5	439.9	454.0	461.7

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	25	26	27	28	29	30	31	32	33	34	35	36
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	476.2	484.3	499.1	514.1	522.8	538.2	547.3	563.2	579.2	589.0	605.5	622.2
MAINTENANCE COSTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	476.2	484.3	499.1	514.1	522.8	538.2	547.3	563.2	579.2	589.0	605.5	622.2
TOTAL COST	476.2	484.3	499.1	514.1	522.8	538.2	547.3	563.2	579.2	589.0	605.5	622.2

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	37	38	39	40	41	42	43	44	45	46	47	48
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	632.7	649.9	667.4	685.1	696.6	714.8	733.3	752.1	771.2	790.6	803.8	823.8
MAINTENANCE COSTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	632.7	649.9	667.4	685.1	696.6	714.8	733.3	752.1	771.2	790.6	803.8	823.8
TOTAL COST	632.7	649.9	667.4	685.1	696.6	714.8	733.3	752.1	771.2	790.6	803.8	823.8

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS 49	50
LAND	0.0	0.0
CONSTRUCTION	0.0	0.0
ENGINEERING	0.0	0.0
EQUIPMENT	0.0	0.0
VEHICLES	0.0	0.0
CONVERSION	0.0	0.0
INTEREST DURING CONST.	0.0	0.0
TOTAL	0.0	0.0
OPERATION EXPENSES		
COST OF ENERGY	844.1	864.7
MAINTENANCE COSTS	0.0	0.0
TOTAL	844.1	864.7
TOTAL COST	844.1	864.7

MINI-HYDRO, BASIC NEEDS
13-FEB-85

13:38:16

COCESULT, EXPERTS-CONSEILS, MONTREAL
PAGE 1

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	1	2	3	4	5	6	7	8	9	10	11	12
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	6601.0	2774.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	1224.0	659.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	2396.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	7825.0	5829.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	470.5	505.4	267.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAINTENANCE COSTS	88.8	95.7	65.5	40.4	40.8	41.2	41.2	41.2	41.6	41.6	42.0	42.1
TOTAL	559.3	601.1	333.3	40.4	40.8	41.2	41.2	41.2	41.6	41.6	42.0	42.1
TOTAL COST	8384.3	6430.1	333.3	40.4	40.8	41.2	41.2	41.2	41.6	41.6	42.0	42.1

PRESENT VALUE = 15871.0

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	13	14	15	16	17	18	19	20	21	22	23	24
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAINTENANCE COSTS	42.2	42.6	42.7	43.1	43.2	43.2	43.7	43.7	44.2	44.3	44.9	45.0
TOTAL	42.2	42.6	42.7	43.1	43.2	43.2	43.7	43.7	44.2	44.3	44.9	45.0
TOTAL COST	42.2	42.6	42.7	43.1	43.2	43.2	43.7	43.7	44.2	44.3	44.9	45.0

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	25	26	27	28	29	30	31	32	33	34	35	36
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	1182.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	1182.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAINTENANCE COSTS	45.6	45.8	46.3	46.9	47.1	47.7	47.9	65.5	66.2	66.4	67.1	67.7
TOTAL	45.6	45.8	46.3	46.9	47.1	47.7	47.9	65.5	66.2	66.4	67.1	67.7
TOTAL COST	45.6	45.8	46.3	46.9	47.1	47.7	1229.9	65.5	66.2	66.4	67.1	67.7

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	37	38	39	40	41	42	43	44	45	46	47	48
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAINTENANCE COSTS	68.0	68.7	69.4	70.1	70.4	71.1	71.9	72.7	73.5	74.3	74.6	75.5
TOTAL	68.0	68.7	69.4	70.1	70.4	71.1	71.9	72.7	73.5	74.3	74.6	75.5
TOTAL COST	68.0	68.7	69.4	70.1	70.4	71.1	71.9	72.7	73.5	74.3	74.6	75.5

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS 49	50
LAND	0.0	0.0
CONSTRUCTION	0.0	0.0
ENGINEERING	0.0	0.0
EQUIPMENT	0.0	0.0
VEHICLES	0.0	0.0
CONVERSION	0.0	0.0
INTEREST DURING CONST.	0.0	0.0
TOTAL	0.0	0.0
OPERATION EXPENSES		
COST OF ENERGY	0.0	0.0
MAINTENANCE COSTS	76.3	77.2
TOTAL	76.3	77.2
TOTAL COST	76.3	77.2

MINI-HYDRO, HEATING AND BASIC NEEDS
14-FEB-85

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COGESULT, EXPERTS-CONSEILS, MONTREAL
PAGE 1

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	1	2	3	4	5	6	7	8	9	10	11	12
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	15650.0	11267.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	3350.0	1805.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	3536.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1768.0	0.0	0.0	0.0
CONVERSION	582.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	19582.5	16608.0	0.0	0.0	0.0	0.0	0.0	0.0	1768.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	895.0	950.1	499.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAINTENANCE COSTS	117.2	126.3	167.0	100.9	102.0	103.1	103.1	103.2	144.3	144.4	145.5	145.7
TOTAL	1012.2	1076.4	666.6	100.9	102.0	103.1	103.1	103.2	144.3	144.4	145.5	145.7
TOTAL COST	20594.7	17684.4	666.6	100.9	102.0	103.1	103.1	103.2	1912.3	144.4	145.5	145.7

PRESENT VALUE = 43563.3

MINI-HYDRO, HEATING AND BASIC NEEDS
14-FEB-85

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COGESULT, EXPERTS-CONSEILS, MONTREAL
PAGE 2

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
INVESTMENTS	13	14	15	16	17	18	19	20	21	22	23	24
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAINTENANCE COSTS	145.9	147.1	147.3	148.5	148.7	149.0	150.1	150.4	151.6	152.1	153.6	154.2
TOTAL	145.9	147.1	147.3	148.5	148.7	149.0	150.1	150.4	151.6	152.1	153.6	154.2
TOTAL COST	145.9	147.1	147.3	148.5	148.7	149.0	150.1	150.4	151.6	152.1	153.6	154.2

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	25	26	27	28	29	30	31	32	33	34	35	36
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	2930.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	2930.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	0.0	0.6	3.2	5.7	6.8	9.6	10.5	14.7	19.3	22.4	30.0	40.3
MAINTENANCE COSTS	155.7	156.3	237.9	239.6	240.2	241.9	242.6	244.4	246.2	247.0	248.8	250.7
TOTAL	155.7	156.9	241.1	245.3	247.0	251.5	253.1	259.1	265.5	269.4	278.8	291.0
TOTAL COST	155.7	156.9	3171.1	245.3	247.0	251.5	253.1	259.1	265.5	269.4	278.8	291.0

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	37	38	39	40	41	42	43	44	45	46	47	48
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	46.4	61.5	79.2	101.5	114.4	130.8	179.0	202.4	244.9	295.8	307.4	343.9
MAINTENANCE COSTS	251.6	253.5	255.5	257.6	258.6	260.7	262.9	265.1	267.3	269.6	270.8	273.2
TOTAL	298.0	315.0	334.7	359.1	373.0	391.5	441.9	467.5	512.2	565.4	578.2	617.1
TOTAL COST	298.0	315.0	334.7	359.1	373.0	391.5	441.9	467.5	512.2	565.4	578.2	617.1

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

YEARS

	49	50
LAND	0.0	0.0
CONSTRUCTION	0.0	0.0
ENGINEERING	0.0	0.0
EQUIPMENT	0.0	0.0
VEHICLES	0.0	0.0
CONVERSION	0.0	0.0
INTEREST DURING CONST.	0.0	0.0
TOTAL	0.0	0.0

OPERATION EXPENSES

COST OF ENERGY	407.7	477.8
MAINTENANCE COSTS	275.7	278.2
TOTAL	683.4	756.0
TOTAL COST	683.4	756.0

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	1	2	3	4	5	6	7	8	9	10	11	12
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	24000.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	130.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	582.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	24712.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	895.0	336.2	350.8	365.6	382.9	400.3	405.5	410.9	428.7	434.3	452.4	458.2
MAINTENANCE COSTS	117.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	1012.2	336.2	350.8	365.6	382.9	400.3	405.5	410.9	428.7	434.3	452.4	458.2
TOTAL COST	25724.7	336.2	350.8	365.6	382.9	400.3	405.5	410.9	428.7	434.3	452.4	458.2

PRESENT VALUE = 36908.1

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	13	14	15	16	17	18	19	20	21	22	23	24
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	464.2	482.7	489.0	507.8	514.4	521.1	540.3	547.4	566.9	574.3	594.2	602.0
MAINTENANCE COSTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	464.2	482.7	489.0	507.8	514.4	521.1	540.3	547.4	566.9	574.3	594.2	602.0
TOTAL COST	464.2	482.7	489.0	507.8	514.4	521.1	540.3	547.4	566.9	574.3	594.2	602.0

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	25	26	27	28	29*	30	31	32	33	34	35	36
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	622.2	630.3	650.9	671.7	680.4	701.6	710.7	732.4	754.2	764.0	786.3	808.8
MAINTENANCE COSTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	622.2	630.3	650.9	671.7	680.4	701.6	710.7	732.4	754.2	764.0	786.3	808.8
TOTAL COST	622.2	630.3	650.9	671.7	680.4	701.6	710.7	732.4	754.2	764.0	786.3	808.8

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	37	38	39	40	41	42	43	44	45	46	47	48
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	819.2	842.2	865.5	889.0	900.5	924.5	948.8	973.4	998.3	1023.5	1036.6	1062.4
MAINTENANCE COSTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	819.2	842.2	865.5	889.0	900.5	924.5	948.8	973.4	998.3	1023.5	1036.6	1062.4
TOTAL COST	819.2	842.2	865.5	889.0	900.5	924.5	948.8	973.4	998.3	1023.5	1036.6	1062.4

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS 49	50
LAND	0.0	0.0
CONSTRUCTION	0.0	0.0
ENGINEERING	0.0	0.0
EQUIPMENT	0.0	0.0
VEHICLES	0.0	0.0
CONVERSION	0.0	0.0
INTEREST DURING CONST.	0.0	0.0
TOTAL	0.0	0.0
OPERATION EXPENSES		
COST OF ENERGY	1088.5	1114.9
MAINTENANCE COSTS	0.0	0.0
TOTAL	1088.5	1114.9
TOTAL COST	1088.5	1114.9

REFERENCE CASE, TOTAL HEATING
14-FEB-85

10:45:08

COGESULT, EXPERTS-CONSEILS, MONTREAL
PAGE 1

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	1	2	3	4	5	6	7	8	9	10	11	12
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	100.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	100.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	424.5	444.7	464.6	479.2	498.4	519.4	521.8	525.5	545.5	547.7	570.3	576.1
MAINTENANCE COSTS	28.4	30.6	32.4	34.2	36.6	38.8	38.8	38.8	41.0	41.0	43.2	43.2
TOTAL	452.9	475.3	496.0	513.4	535.0	558.2	560.6	564.3	586.5	588.7	613.5	619.3
TOTAL COST	553.0	475.3	496.0	513.4	535.0	558.2	560.6	564.3	586.5	588.7	613.5	619.3

PRESENT VALUE = 17207.3

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	13	14	15	16	17	18	19	20	21	22	23	24
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	112.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	112.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	581.9	604.7	611.2	633.9	640.4	647.5	670.8		701.9	716.0	747.5	761.8
MAINTENANCE COSTS	43.2	45.6	45.6	47.8	47.8	47.8	50.0		52.2	52.2	54.6	54.6
TOTAL	625.1	650.3	656.8	681.7	688.2	695.3	720.8		754.1	768.2	802.1	816.4
TOTAL COST	625.1	762.5	656.8	681.7	688.2	695.3	720.8	[illegible]	[illegible]	768.2	802.1	816.4

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

	YEARS											
	25	26	27	28	29	30	31	32	33	34	35	36
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	794.6	810.3	843.6	877.6	895.6	931.3	949.8	987.0	1024.6	1044.7	1085.4	1125.3
MAINTENANCE COSTS	56.8	56.8	59.0	61.2	61.2	63.4	63.4	64.6	68.0	68.0	70.2	72.6
TOTAL	851.4	867.1	902.6	938.8	956.8	994.7	1013.2	1051.6	1092.6	1112.7	1155.6	1197.9
TOTAL COST	851.4	867.1	902.6	938.8	956.8	994.7	1013.2	1051.6	1092.6	1112.7	1155.6	1197.9

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS
(x 1000 dollars)

	YEARS											
	37	38	39	40	41	42	43	44	45	46	47	48
INVESTMENTS												
LAND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	112.2	0.0	0.0
ENGINEERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTEREST DURING CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	112.2	0.0	0.0
OPERATION EXPENSES												
COST OF ENERGY	1149.3	1190.8	1234.4	1279.3	1303.4	1350.2	1397.7	1446.5	1497.8	1548.1	1578.7	1632.7
MAINTENANCE COSTS	72.6	74.8	77.0	78.0	79.2	81.6	83.8	86.0	88.2	90.6	90.6	92.8
TOTAL	1221.9	1265.6	1311.4	1357.3	1382.6	1431.8	1481.5	1532.5	1586.0	1638.7	1669.3	1725.5
TOTAL COST	1221.9	1265.6	1311.4	1357.3	1382.6	1431.8	1481.5	1532.5	1586.0	1750.9	1669.3	1725.5

PRESENT VALUE OF AN ALTERNATIVE
IN CONSTANT DOLLARS

(x 1000 dollars)

YEARS

	49	50
LAND	0.0	0.0
CONSTRUCTION	0.0	0.0
ENGINEERING	0.0	0.0
EQUIPMENT	0.0	0.0
VEHICLES	0.0	0.0
CONVERSION	0.0	0.0
INTEREST DURING CONST.	0.0	0.0
TOTAL	0.0	0.0
OPERATION EXPENSES		
COST OF ENERGY	1686.5	1743.7
MAINTENANCE COSTS	95.0	97.2
TOTAL	1781.5	1840.9
TOTAL COST	1781.5	1840.9

APPENDIX 3

ACCOUNT OF THE VISIT OF Z. AZIZ AND A. STOIAN TO WASKAGANISH

Project 2082

RUPERT HOUSE

MINI-POWERHOUSE

ACCOUNT OF THE VISIT OF

Z. AZIZ AND A. STOIAN TO THE SITE

JULY 20/83

ITINERARY		TIME
Leave Dorval	Nordair Flight 0673	7:30
Arrive Val d'Or		8:30
Leave by helicopter Bell 206L of Heli-voyageur		9:30
Arrive Rupert House		12:05
Aerial Survey		(see sketch)
Leave Rupert House		18:00
Arrive Val D'Or		20:15
Leave Val d'Or	Air Canada Flight 0558	21:10
Arrive Montreal		21:55

PURPOSE OF THE VISIT

The visit was organized to carry out a reconnaissance survey of the sites on the Rupert, Pontax and Broadback rivers, located with the help of aerial photographs and topographic maps.

1 - Rupert House Band Council made available the services of Messrs. Gordon Blackued and Rupert Erless as guides to accompany the group during the helicopter flight and to brief the group on the sensitivity of each perspective site with respect to hunting, fishing and ecological aspects. No such aspect was indicated by the guides in relation to any site.

2 - As shown on the accompanying sketch, the sites r-1, r-2 and r-3 were inspected on the Rupert River, sites P-6 to P-1 on the Pontax River and b-1 and b-2 on the Broadback River.

.../2

The sites r-3 and P-6 look promising, particularly r-3 which is suitedly located on the left bank of the Rupert River, can easily lend itself to a mini-hydro development and is about 35 km from the village of Rupert House. The site P-6 has good water flow, a sound bedrock foundation, a water fall of about 12 m and seems to be promising, but has its disadvantages that it is about 50 km away and any development incorporates construction of access roads and transmission lines, including the crossing of the Rupert River.

The other schemes are minor and have disadvantages because of the distance, inadequate catchment area, low water heads, etc., but were looked at nevertheless to have an inventory of the sites in the vicinity.

4 - The sand and gravel borrow area presently used by Rupert House was visited. It is connected to the village by around 20 km of good quality gravel road. The borrow area seems to be an old beach deposit consisting of lenses of fine to medium gravel in a sandy matrix. The northern part of the deposit seems to be more gravelly while the southern part is more sandy. It looks like this depot with screening could provide fine aggregate for the r-3 scheme, which is only about 12 to 15 km to the east.

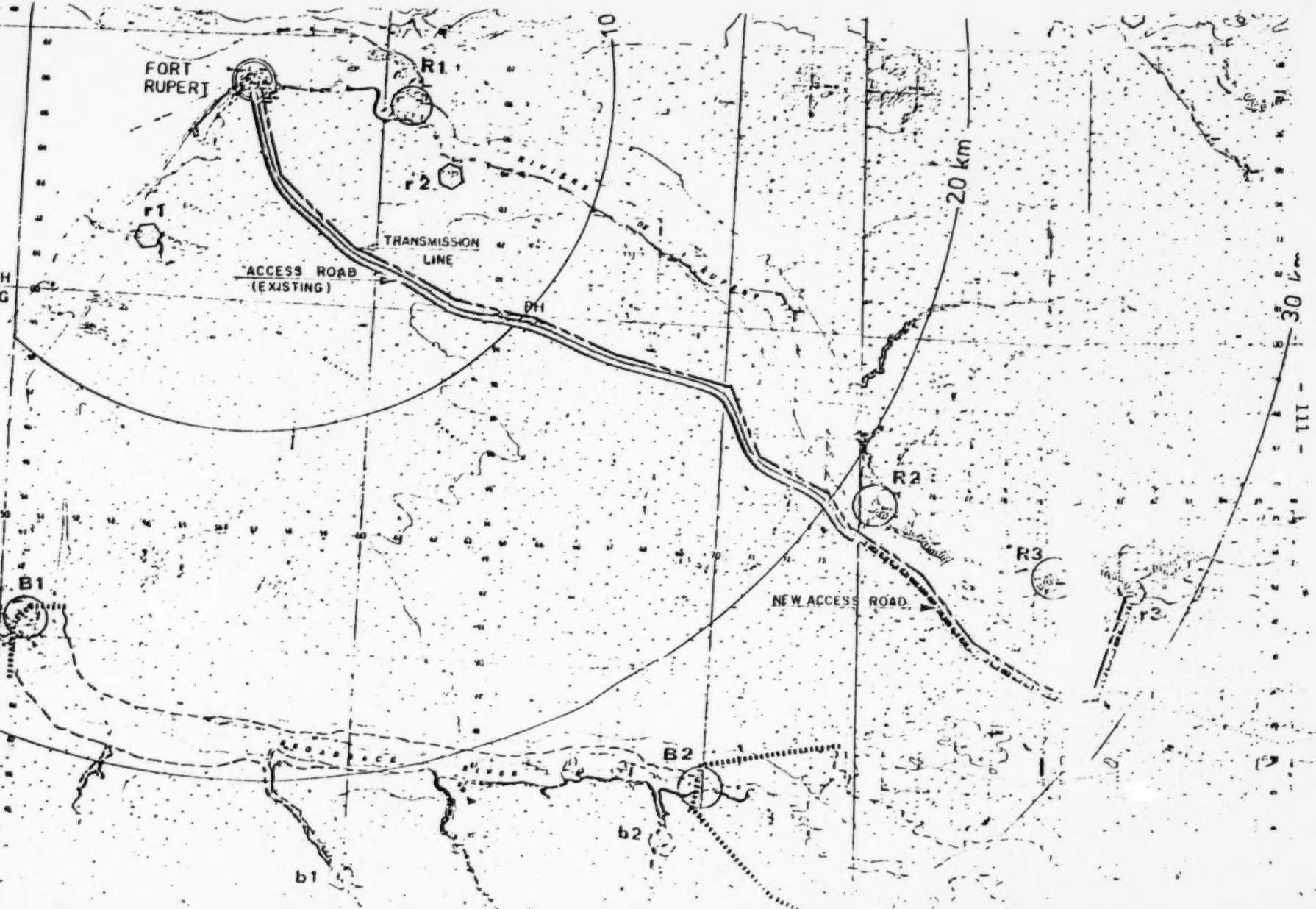
5 - At the end of the trip, the Band Council Chief, Mr. Bill Namagoose was visited in the Band Council Office and was briefed on the mission and on very preliminary findings.

A. Stoian

Z. Aziz

APPENDIX 4

LIE OF THE ACCESS ROAD AND THE TRANSMISSION LINE FOR THE MINI-HYDROELECTRIC POWER PLANT


FORT RUPERT
R1
r2
r1
TRANSMISSION LINE
ACCESS ROAD (EXISTING)
PH
10
20 km
30
R2
R3
r2
B1
NEW ACCESS ROAD
B2
b2
b1

APPENDIX 5

EFFECTIVE PEAK POWER DEMAND PER HOUSE

Appendix 5

Effective peak power demand per house

The peak power demand coming from basic electric needs must be carefully calculated in order to not overestimate it. It cannot simply be defined as the sum of each appliance power found in the houses because the probability that every appliances are used at the same time is very low. Moreover, the probability that every fridge in the community will run at the same time is also very low.

A more global approach is then necessary. The following relation will be used:

$$\frac{\text{total electricity consumption}}{\text{peak power demand}} = \text{hours of utilization}$$

The following hours of utilization for Waskaganish are derived from Indian and Northern Affair Canada statistics:

Month			Hours
April	83	=	580
May	83	=	597
June	83	=	673
July	83	=	746
August	83	=	553
September	83	=	625
October	83	=	491
November	83	=	400
December	83	=	400
January	83	=	443
February	83	=	508

The demand is more heavily concentrated during the winter season. To define the future peak power demand, it is more advisable to use a security margin of 25% which means the lowest hours of utilization will become:

400 hours x 75 % = 300 hours

Since the basic needs per house are estimated at 10 000 KWh and the fact that 40% of the basic electricity is consumed between November 1 st and March 1 st,[1] it is assumed that 1 000 KWh are consumed during each of these months.

---

(1) Ralph Lebens, Passive solar heating design, Applied Science Publishers, London, U.S.A., 1980.

The peak power demand is :

$$\frac{\text{Total electricity consumption}}{\text{hours of utilization}} = \text{Peak power demand}$$

$$\frac{1\ 000\ \text{KWh}}{300\ \text{hours}} = 3.3\ \text{KW/house}$$

APPENDIX 6

DECREE No. 300-84

Partie 2 GAZETTE OFFICIELLE DU QUÉBEC, 4 avril 1984, 116e année, nº 15 1523

Décrets

Gouvernement du Québec

Décret 300-84, 8 février 1984

Loi sur la qualité de l'environnement (L.R.Q., chap. Q-2)

Projets municipaux du programme d'assainissement des eaux — Cadre de gestion

CONCERNANT le cadre de gestion relatif à la réalisation des projets municipaux du programme d'assainissement des eaux

ATTENDU QUE la Loi sur la qualité de l'environnement (L.R.Q., chap. Q-2) prévoit au premier alinéa de l'article 2, que le ministre a pour fonction d'élaborer et de proposer au gouvernement une politique de protection de l'environnement, de mettre cette politique en œuvre, d'en coordonner l'exécution;

ATTENDU QUE le gouvernement a adopté, par le Décret 1000-83 du 18 mai 1983, un cadre de gestion relatif à la réalisation des projets municipaux d'assainissement des eaux du programme d'assainissement;

ATTENDU QU'IL est nécessaire de modifier ce cadre de gestion;

IL EST ORDONNÉ, en conséquence, sur la proposition du ministre de l'Environnement:

QUE le présent cadre de gestion relatif à la réalisation des projets municipaux du programme d'assainissement des eaux soit approuvé;

QUE le ministre de l'Environnement soit autorisé à conclure une convention, au nom du Gouvernement du Québec, avec les corporations municipales visées par le présent cadre de gestion selon un texte substantiellement semblable à celui faisant partie du présent décret;

QUE le ministre de l'Environnement soit autorisé, au nom du Gouvernement du Québec, à signer des addenda aux conventions conclues avec les corporations municipales ou déposées auprès desdites corporations pour modifier ces conventions selon les modalités prévues au présent cadre de gestion;

QUE le présent décret remplace le Décret 1000-83 du 18 mai 1983.

Le greffier du Conseil exécutif,
LOUIS BERNARD

Cadre de gestion relatif à la réalisation des projets municipaux du programme d'assainissement des eaux

SECTION I
DISPOSITIONS GÉNÉRALES

1.1 Le présent cadre de gestion établit les modalités d'application du programme d'assainissement des eaux aux municipalités, lequel fait partie de la politique d'assainissement des eaux du gouvernement élaborée conformément aux dispositions de l'article 2 de la Loi sur la qualité de l'environnement (L.R.Q., chap. Q-2).

1.2 Le présent cadre vise à préciser le cadre des interventions municipales dans le programme d'assainissement des eaux et, en particulier, les dispositions normatives, le contenu du plan d'équipement et le mode d'acceptation et de suivi de la programmation.

1.3 Dans le présent document, à moins que le contexte n'indique un sens différent, on entend par:

a) « Loi »: la Loi sur la qualité de l'environnement (L.R.Q., chap. Q-2);

b) « Ministre »: le Ministre de l'Environnement;

c) « Ministère »: le ministère de l'Environnement;

d) « Sous-ministre »: le sous-ministre de l'Environnement;

e) « Société »: la Société québécoise d'assainissement des eaux;

f) « Maître des ouvrages »: une municipalité, au sens du paragraphe 10° de l'article 1 de la Loi, pour le compte de qui les ouvrages

g) « Maître d'œuvre »: personne physique ou morale qui, pour sa compétence technique, est chargée par le maître des ouvrages de diriger et de contrôler l'exécution des ouvrages et de proposer leur réception;

h) « Programme d'assainissement »: l'ensemble des mesures nécessaires pour assainir les cours d'eau, tel que présenté au plan d'équipement;

i) « Étude d'avant-projet »: étude réalisée dans le but de définir la solution de traitement des eaux usées ainsi que la solution d'interception et d'établir leurs coûts ainsi que les échéanciers de réalisation.

Cette étude permet de plus de déterminer les débits et les charges à traiter. Elle fixe les objectifs de traitement, les objectifs de réduction des eaux parasites et précise le mandat de l'étude ÉPIC.

j) « Design préliminaire »: études visant à élaborer et à finaliser la conception des solutions d'interception et de traitement énoncées lors des études d'avant-projet;

k) « Convention »: contrat intervenu entre le Ministre et une corporation municipale en vue d'assainir les eaux usées municipales et qui définit la nature et l'échéancier de réalisation des ouvrages, les modalités de mise en œuvre et de financement;

l) « Études ÉPIC »: analyse détaillée du réseau d'égouts municipal portant sur les eaux parasites par infiltration et par captage, exécutée suivant le mandat défini dans le cadre de l'étude d'avant-projet et réalisée en conformité avec les devis du Ministère; cette analyse permet de déterminer la nature des travaux de réhabilitation nécessaires pour satisfaire les objectifs de réduction des eaux parasites, établis par le Ministère;

m) « Réhabilitation »: ensemble des travaux visant à réduire les apports d'eaux parasites d'infiltration et de captage dans les réseaux d'égouts et à redonner aux réseaux d'égouts une vocation compatible avec l'ensemble du projet d'assainissement réalisé sur le territoire visé;

n) « Collecteur »: conduite d'un réseau d'égouts, qui se déverse dans un ouvrage d'interception;

o) « Émissaire de l'usine »: canalisation qui évacue les eaux d'une usine de traitement présente ou future, et qui les transporte au point de rejet;

p) « Interception »: ensemble des conduites d'égouts, des postes de relèvement, des postes de pompage, des travaux de raccordement des collecteurs et des émissaires existants requis afin d'acheminer les eaux usées déversées par ces collecteurs et émissaires à l'usine de traitement;

q) « Traitement »: ensemble des ouvrages requis en vue de traiter les eaux usées municipales, y compris les postes de pompage ou de relèvement qui assurent également gravitaire à travers l'usine de traitement jusqu'à l'émissaire de l'usine;

r) « Objectifs de traitement »: les résultats escomptés à l'usine d'épuration municipale quant au taux d'enlèvement des matières polluantes acheminées à l'usine d'épuration et établis au cours de l'étude d'avant-projet, en concordance avec les objectifs d'assainissement du cours d'eau récepteur.

s) « Coûts d'exploitation des ouvrages »: les sommes versées en salaires et bénéfices marginaux directement reliées à l'exploitation et à l'entretien des ouvrages d'assainissement, les coûts de l'électricité, des carburants et autres sources d'énergie, les dépenses courantes d'entretien, les réactifs et produits chimiques ainsi que les frais afférents à la gestion des boues;

t) « Frais de gestion »: sommes versées à la Société ou à un organisme intermunicipal pour la gestion des ouvrages d'assainissement et visant à faire réaliser ces ouvrages conformément aux conditions contractuelles de la convention et aux règles de l'art, dans le cadre des échéanciers et des enveloppes budgétaires établies.

u) « Principale place d'affaires »: le principal établissement d'où les affaires sont dirigées et où le personnel de maîtrise et l'équipement se trouvent ordinairement.

v) « Projet clé en main »: l'approche de gestion « clé en main » consiste, pour la Société ou pour une entreprise privée à effectuer, sur la base des études d'avant-projet, la conception et la réalisation complète d'un projet d'assainissement, couvrant l'ensemble ou une partie des ouvrages d'assainissement décrits à la Convention, ainsi que l'exploitation pour une période minimale de cinq ans des ouvrages ainsi construits et peut aussi comprendre le financement à long terme, conformément aux dispositions de la Convention; la municipalité devient propriétaire des ouvrages d'assainissement lors de la réception provisoire des travaux.

w) « Contrat de clé en main »: contrat par lequel le maître des ouvrages confie à la Société ou à une entreprise privée sur la base des études d'avant-projet, la conception et la réalisation complète d'un projet d'assainissement couvrant l'ensemble ou une partie des ouvrages d'assainissement décrits à la convention ainsi que l'exploitation pour une période minimale de cinq ans des ouvrages ainsi construits, ce contrat peut également comprendre le financement à long terme.

SECTION 2
DISPOSITIONS NORMATIVES DES CONVENTIONS

2.1 Ouvrages admissibles

Les ouvrages incluent tous les travaux requis pour leur réalisation, décrits ci-après sont admissibles:

a) Étude d'avant-projet;

b) Études ÉPIC;

c) Réhabilitation;

d) Interception;

e) Traitement;

f) Achat des ouvrages: les ouvrages d'assainissement exécutés ou en voie d'exécution dans le cadre d'ententes antérieures au programme d'assainissement des eaux, intervenues entre le Gouvernement du Québec ou ses représentants et la corporation municipale, sont admis au programme d'assainissement. Ces ouvrages seront décrits en annexe à la convention.

2.2 Coûts des ouvrages admissibles

Les coûts des ouvrages admissibles sous réserve des dispositions des articles 2.8.3 et 2.8.5 comprennent:

2.2.1 Les coûts des études ÉPIC et des études d'avant-projet

a) Les sommes versées pour les contrats d'exécution de ces études ou pour des contrats de service de laboratoire ou d'expertises auxquelles s'ajoutent les sommes versées en salaires et bénéfices marginaux aux employés du maître des ouvrages pour tout travail directement relié à la réalisation de ces études.

b) Les frais de financement temporaire de ces études.

c) Les frais de gestion de ces études.

2.2.2 Les coûts de construction

a) Les sommes versées pour l'acquisition des terrains, des immeubles et des servitudes nécessaires, pour le déplacement ou la démolition de certains bâtiments ou installations en vue de la construction des ouvrages, pour les frais d'arpentage et pour les frais inhérents à l'exécution des ouvrages;

b) Les sommes versées aux entrepreneurs et fournisseurs pour l'exécution des ouvrages suivant les termes de leurs contrats respectifs,

c) Les sommes versées au gouvernement, aux corporations municipales ou à d'autres organismes d'utilité publique lors de la construction de différents éléments des ouvrages, conformément à tout mandat qui peut leur être confié par le maître d'œuvre;

d) Toute taxe payée par le maître d'œuvre pour tout matériau ou équipement acquis pour les ouvrages;

e) Les sommes versées en salaires et bénéfices marginaux, au surintendant de l'usine de traitement, permanent ou contractuel, à compter de son embauche jusqu'à la réception provisoire des travaux de l'usine de traitement ainsi que les frais versés durant cette période pour des stages de formation dans des écoles ou instituts du Québec;

f) Les sommes versées en salaires et bénéfices marginaux au profit des employés du maître des ouvrages pour tout travail directement relié à la réalisation des travaux de réhabilitation;

g) Les sommes payées pour les équipements requis à l'exploitation des ouvrages d'assainissement, lesquels devront être inclus aux plans et devis ou être préalablement approuvés par le Ministère.

2.2.3 Les frais contingents reliés aux coûts de construction

a) Les sommes payées en honoraires professionnels et en frais à des spécialistes en forage, sondage et analyse des sols, contrôle de la qualité, mesures de débits, échantillonnage et analyse des eaux usées ou autres disciplines analogues;

b) Les sommes payées aux ingénieurs, experts-conseils et autres personnes ou firmes pour la réhabilitation du réseau d'égouts;

c) Les sommes payées aux ingénieurs, architectes, conseillers juridiques, arpenteurs-géomètres, experts-conseils et autres professionnels pour le design préliminaire, l'arpentage (autres que celles versées en vertu de l'article 2.2.2 *a*)), les relevés, la préparation des plans, devis et cahiers des charges des ouvrages et des documents d'appels d'offres, les documents légaux, la coordination et la surveillance de la construction;

d) Les sommes payées en salaires et bénéfices marginaux au profit des employés du maître des ouvrages pour tout travail directement relié à l'établissement du plan d'assainissement, au design préliminaire d'interception et de traitement, à la préparation des plans, devis et cahiers des charges et à la surveillance des travaux d'exécution,

e) Les sommes versées à la Société ou à l'organisme intermunicipal pour la gestion des ouvrages qui relèvent de la présente convention;

f) Les sommes versées pour les frais de financement temporaire des ouvrages.

2.3 Frais de financement admissibles

Les frais de financement admissibles sont tous les frais de financement permanent, tous les frais d'émission d'obligations incluant notamment l'escompte sur obligations ainsi que tous les frais de refinancement et d'intérêt pendant la durée de ou des emprunts.

2.4 Ouvrages et coûts non admissibles

Les coûts et les ouvrages décrits ci-après ne sont pas admissibles aux subventions gouvernementales dans le cadre du programme d'assainissement:

2.4.1 Ouvrages non admissibles

a) Tous les ouvrages qui n'appartiennent pas dans l'article 2.1 (notamment les collecteurs);

b) Les ouvrages de réhabilitation non reconnus essentiels par le Ministère à la suite d'études sur les réseaux d'égouts;

c) Les ouvrages de traitement qui ne sont pas la propriété du maître des ouvrages ou d'une corporation municipale;

d) Les installations septiques communautaires desservant moins de 10 résidences ou logis différents;

e) Les conduites locales visant à acheminer les eaux usées des usagers aux installations septiques communautaires.

2.4.2 Coûts non admissibles

a) Tous les coûts et les frais qui n'apparaissent pas aux articles 2.2 et 2.3;

b) Les dépenses relatives à la mise en état d'équipements et de bâtiments existants, utilisables mais souffrant d'un manque d'entretien;

c) Le service de la dette des ouvrages d'assainissement existants (poste de pompage, intercepteurs, usines d'épuration, etc.);

d) Les coûts d'exploitation des ouvrages et l'achat de produits chimiques, de véhicules, d'outils, de fournitures diverses, de tout autre bien de même nature et de mobilier, à l'exception du mobilier de laboratoire.

2.5 Élaboration de la solution

2.5.1 Critères de design

Le design préliminaire ainsi que la préparation des plans et cahiers des charges des ouvrages d'assainissement doivent se faire en respectant les exigences du Ministère c'est-à-dire, qu'ils doivent être basés sur les résultats des études d'avant-projet.

Dans le cadre des études d'avant-projet, la conception des ouvrages tient compte des critères suivants:

a) elle est basée, pour les ouvrages de traitement, sur les besoins immédiats de la population à desservir en vérifiant les conditions d'opération des dix premières années de fonctionnement de l'usine. Tout ajustement pour tenir compte de la variation démographique, doit être autorisé par le Sous-ministre;

b) elle tient compte des besoins additionnels prévisibles d'environ 30 ans pour les ouvrages d'interception jusqu'à concurrence de 30 % des débits actuels du système d'interception, à l'exception des construction en tunnel où la rentabilité des investissements est l'élément de considération;

c) elle s'appuie sur une étude démographique visée par le Bureau de la statistique du Québec et, dans le cas des ouvrages d'interception, sur un schéma d'ensemble d'occupation du territoire ou sur un plan d'urbanisme ou encore sur un plan de zonage, si disponibles;

d) elle est basée sur une analyse coût-opportunité afin de respecter la nature des eaux usées provenant des bassins domestiques, en évitant de les déverser dans les réseaux unitaires et on les raccordant à un égout domestique ou à un ouvrage d'interception;

e) elle tient compte de la vie utile des équipements et des ouvrages;

f) elle est basée, le cas échéant, sur les résultats de mesures de débits et de charges polluantes ainsi que sur toutes autres analyses et données quantitatives et qualitatives des eaux usées;

g) elle tient compte des objectifs de traitement nécessaires pour atteindre le niveau de qualité désiré du cours d'eau récepteur;

h) elle est fondée, eu égard aux coûts, sur la solution qui optimalise l'emploi des matériaux, produits et équipements fabriqués au Québec.

2.5.2 Critères de choix de la solution

Dans le cadre des études d'avant-projet, le Ministère procède à une analyse économique comparative des différentes solutions ayant fait l'objet d'une consultation auprès de la municipalité et retient le choix d'une solution d'interception et de traitement.

Pour réaliser ce choix, le Ministère:

a) ne retient pour l'analyse économique comparative, que les seules variantes permettant de satisfaire les objectifs de traitement, des variantes jugées faciles d'entretien, peu vulnérables aux surcharges, peu sensibles aux interventions accidentelles des préposés à l'entretien et suffisamment flexibles pour faire face aux conditions variables d'exploitation;

b) considère pour l'analyse économique comparative, le total des coûts des ouvrages et des coûts d'exploitation actualisés d'une période de 20 ans. La variante présentant les coûts totaux les plus bas est retenue à la condition que les coûts de construction associés à cette variante n'excèdent pas 10 % de ceux de la variante jugée la plus économique sur la base des coûts de construction parmi celles retenues pour l'analyse économique comparative.

La formule servant à déterminer les coûts totaux de chacune des variantes est la suivante:

$$T = C + (E \times K)$$

T = coûts totaux d'une variante

C = coût des ouvrages en dollars constants, c'est-à-dire le coût estimé pendant l'étude d'avant-projet

E = coût d'exploitation de la première année en dollars constants

K = facteur d'utilisation: facteur qui, multiplié par le coût d'exploitation de la première année, donne le coût d'exploitation actualisé. Le facteur d'actualisation (13,59) est basé sur un taux de rendement de 4 % pendant 20 ans, c'est-à-dire, l'écart entre le taux d'intérêt et le taux d'inflation.

2.6 Modalités d'approbation et de réalisation des travaux

a) Après l'approbation de la programmation conformément aux dispositions prévues à la section 4, le Ministère réalise pour chaque corporation municipale, une étude d'avant-projet dont les résultats sont remis au maître des ouvrages aux fins d'être utilisés lors du design préliminaire.

b) Le Ministère demeure responsable de la réalisation des études d'avant-projet et un décret spécifique l'autorise à confier un mandat d'exécution à la Société. La municipalité est invitée à participer au suivi de l'étude d'avant-projet.

c) Suite à la réalisation de l'étude d'avant-projet, le Ministère peut réaliser l'étude ÉPIC. Le Ministère est maître d'oeuvre de cette étude et un décret spécifique autorise le Ministère à confier selon les besoins, un mandat d'exécution à la Société; la municipalité est invitée à participer au suivi de cette étude ÉPIC;

d) Le ministre de l'Environnement et la municipalité signent une convention substantiellement semblable à la convention-type apparaissant à la section 7. Cette convention fait état des solutions d'interception et de traitement retenues suite à l'étude d'avant-projet et précise les objectifs de traitement, les objectifs de réduction des débits d'eaux parasites ainsi que la nature, l'échéancier et le coût des ouvrages à réaliser. Aucun travail exécuté avant la signature de cette convention n'est admissible, sauf s'il y a recherche tel que prévu à l'article 2.1 *f*).

e) Le maître des ouvrages est maître d'oeuvre dans le design préliminaire, de la préparation des plans et devis et de la réalisation des ouvrages d'assainissement. Il peut soit conserver la maîtrise d'oeuvre ou encore la confier à la Société; il peut également réaliser le projet suivant la formule dite projets « clé en main ». La réalisation du projet selon la formule dite « clé en main » peut se faire par l'entremise de la Société ou d'une entreprise privée;

f) Suite à la signature de la convention, le maître d'oeuvre élabore dans le cadre du design préliminaire la conception des solutions d'interception et de traitement retenues lors de l'étude d'avant-projet. Le rapport final concernant le design détaillé de la solution d'interception et de la solution de traitement doit être soumis au Ministère pour approbation. Dans le cas de projets « clé en main », la contrat visé à l'article *f* tient lieu de rapport aux fins d'approbation;

g) Après avoir obtenu les approbations du Ministère visées aux paragraphes *f* ou *f*, le maître d'oeuvre prépare les plans, les devis et les cahiers de charges et doit les soumettre au Ministère pour autorisation. Après acceptation, le Ministère délivre une autorisation en vertu de l'article 32 de la Loi. Aucun lancement d'appel d'offre, achat ou location d'équipement ou réalisation de travaux ne peuvent être faites sans l'accord du Ministère;

h) Seul dans le cas où l'approche des projets « clé en main » est retenue, la corporation municipale s'engage à adjuger tous les contrats de construction, de location d'équipement et d'acquisition de biens à la suite d'appels d'offres aux soumissionnaires ayant leur principale place d'affaires au Québec. Une copie des appels d'offres et une copie du contrat sont transmises au Ministère.

i) Dans le cas où l'approche des projets « clé en main » est retenue, la corporation municipale est responsable, conclure une convention à cet effet avec les ministres de l'Environnement et des Affaires municipales dans laquelle sont précisées les conditions du contrat « clé en main » et les modalités de son adjudication.

Suite à cette convention « clé en main », la municipalité demande des propositions de contrat « clé en main » qui doivent être basées sur la convention et respecter les conditions ainsi que toute autre condition établie par les ministères des Affaires municipales et de l'Environnement. Avant d'accepter un contrat « clé en

main », la municipalité doit avoir reçu au moins deux (2) propositions soumises, pour les mêmes ouvrages, par des entreprises distinctes et non-apparentées.

L'adjudication du contrat « clé en main » ne peut se faire qu'après son approbation par les ministres de l'Environnement et des Affaires municipales. Il devra de plus être autorisé par la Commission municipale du Québec dans le cas où le financement à long terme est assumé par le cocontractant.

f) Toute modification aux ouvrages autorisés doit faire l'objet d'une acceptation du Ministère et d'une autorisation en vertu de l'article 32 de la Loi.

h) Le financement à long terme du coût total de réhabilitation des ouvrages peut s'effectuer en plusieurs tranches ou émissions durant le déroulement de leur réalisation. Pour chacune des tranches ou émissions, il suffisent les pièces et documents requis par la convention afin de permettre au Ministère de statuer sur l'admissibilité des coûts des ouvrages tel que défini aux articles 2.1, 2.2, 2.3, 2.8.2 et 2.8.5 et d'établir les sommes correspondant à la quote-part du gouvernement ou financement de ces ouvrages;

i) Le maître des ouvrages est responsable de la qualité et du suivi technique des travaux et, à cette fin, transmet au Ministère les pièces et documents techniques requis par la Convention.

j) Le maître des ouvrages doit s'assurer que le Ministère reçoive mensuellement un état de l'avancement du projet de même qu'un état des montants déposés et engagés à partir de la date de signature de la convention et ce sous la forme spécifiée par le Ministère.

2.7 Politique d'achat

La corporation municipale est tenue, en vertu de la Convention, d'appliquer la politique d'achat du Gouvernement du Québec. Une copie de l'approbation du design préliminaire ou du contrat des travaux « clé en main » doit être transmise à la Commission permanente et interministérielle des achats (C.P.I.A.) afin de faciliter son intervention auprès des concepteurs et des fournisseurs.

2.8 Assistance financière

Les modalités décrites ci-dessous s'appliquent à l'ensemble des corporations municipales inscrites à la programmation.

2.8.1 Participation financière du gouvernement

a) Coût de l'étude d'avant-projet	100 %
b) Coût des études ÉPIC	100 %
c) Coût du traitement	90 %
d) Coût de l'interception et de la réhabilitation du réseau.	
— Pour la tranche des travaux dont le rapport à l'évaluation municipale est inférieur à l'évaluation à 2 $/100 $ d'évaluation	66 ⅔ %
— Pour la tranche des travaux dont le rapport est compris entre 2 $ et 4 $/100 $ d'évaluation	75 %
— Pour la tranche des travaux dont le rapport est supérieur à 4 $/100 $ d'évaluation	90 %

Toute autre subvention provenant des Gouvernements du Canada et du Québec, ou de leurs agences, consentie à la corporation municipale pour ces ouvrages, sera déduite de la participation du Gouvernement du Québec.

2.8.2 Évaluation foncière admise

Pour les ouvrages d'interception et de réhabilitation, le pourcentage de la participation financière du gouvernement sera basé sur l'évaluation foncière imposable uniformisée de la municipalité telle qu'établie au moment de la signature de la convention ou de l'addenda pour les conventions signées antérieurement au 18 mai 1983; le Sous-ministre ou la personne qu'il désigne pourra, dans des cas exceptionnels qui le justifient, accepter que l'évaluation foncière uniformisée qui correspond au territoire desservi par les ouvrages d'assainissement soit retenue.

Durant la réalisation de ces ouvrages, le pourcentage sera celui établi provisoirement lors de la signature de la convention. Ce pourcentage sera réajusté définitivement à la date de la réception provisoire du dernier ouvrage d'interception.

2.8.3 Modalités de paiement

a) Pour les études d'avant-projet, confiées à des firmes privées et financées par la Société, le Ministre définira les coûts des études ainsi que les frais réels (pour l'administration et le financement temporaire), lesquels ne peuvent excéder 15,5 % des coûts des études. Les paiements impliqués peuvent être effectués par remboursement d'emprunt à long terme ou autrement.

b) Pour les études ÉPIC, le gouvernement paie les coûts des études ainsi que les frais réels (pour la gestion et le financement temporaire) qui ne peuvent excéder 15,5 % des coûts des études; le calcul des frais de la Société est établi par les modalités du règlement concernant la gestion financière de la Société. Ces paiements peuvent être effectués par remboursements d'emprunts à long terme ou autrement.

c) Pour les ouvrages d'interception, de réhabilitation et de traitement, pour lesquels la corporation municipale contracte des emprunts à long terme, le gouvernement rembourse à la corporation municipale sa partie du coût des ouvrages reconnus par la convention suivant les échéanciers des émissions d'obligations;

d) Si la corporation municipale confie à la Société sa maîtrise d'œuvre, le gouvernement verse sa part des coûts à la Société aux conditions de la convention;

e) Dans le cas des projets « clé en main », la municipalité pourra faire appel à l'entreprise privée pour le financement à long terme; le contrat « clé en main » devra alors préciser les modalités de financement; le gouvernement verse néanmoins sa part des coûts à la municipalité aux conditions de la convention.

f) Le Ministère pourra après autorisation du Conseil du Trésor, rembourser sa partie du coût reconnu par la Convention selon les modalités différentes de celles prévues aux alinéas *c*, *d* et *e*.

g) Le gouvernement respecte ses obligations pour autant que la corporation municipale respecte aussi les siennes, telles que définies dans la convention-type faisant partie de la présente.

2.8.4 Indexation des coûts

Les coûts de chacun des ouvrages couverts par la convention sont automatiquement indexés au 1er avril de chaque année. L'indexation portera sur les montants prévus à la convention à l'égard des ouvrages n'ayant pas fait l'objet de contrat à cette date. Le calcul sera effectué suivant la moyenne annuelle des indices des prix de la construction non résidentielle, tels que publiés mensuellement par Statistique Canada.

2.8.5 Frais contingents

Les coûts des ouvrages décrits à la convention incluent les frais contingents suivants:

a) Pour les honoraires professionnels (incluant design préliminaire, plans, devis et cahiers des charges, appels d'offre et surveillance des travaux), un pourcentage variable des coûts de construction de l'ordre de:

7,0 % pour la réhabilitation
8,0 % pour l'interception
10,0 % pour le traitement

Ces pourcentages incluent les frais contingents énumérés à l'article 2.2.3 *d*.

b) Pour les frais de laboratoire (incluant forage et sondage, contrôle de qualité, de la compaction et du béton, essais d'imperméabilité, échantillonnage et mesures de débit, etc.), un pourcentage des coûts de construction de l'ordre de:

0,5 % pour la réhabilitation
1,5 % pour l'interception
2,0 % pour le traitement

c) Pour les frais légaux (incluant frais de recherche, frais d'arpentage et honoraires professionnels et frais reliés à l'expropriation), un pourcentage de l'ordre de 1 % des coûts de construction.

d) Pour les frais de gestion de la Société ou des organismes intermunicipaux, les frais réels ne pouvant excéder 3,5 % des coûts de construction et des coûts identifiés aux paragraphes 2.2.3 *a*, *b*, *c* et *d*, le calcul des frais réels de la Société est établi suivant les modalités du règlement concernant la gestion financière de la Société;

e) Pour le financement temporaire un pourcentage de l'ordre de 4,0 % des coûts de construction et des coûts identifiés aux paragraphes 2.2.3 *a*, *b*, *c* et *d*.

L'ensemble des frais contingents ne doit pas dépasser, 25 % des coûts de construction apparaissant à l'article 2.2.2. Tout ce qui est en plus de 25 % du coût de construction des ouvrages est entièrement à la charge de la corporation municipale; feront exception à cette règle les ouvrages visés par les conventions signées antérieurement au 17 mars 1982.

Si des situations exceptionnelles l'exigent, le Conseil du trésor pourra, sur demande du Ministère, décider d'approuver un pourcentage supérieur à 25 % pour les frais contingents.

Dans le cas de projets clé en main, les frais contingents décrits aux paragraphes 2.8.5 *a*, *b*, *c* et *e* sont inclus dans le coût des ouvrages établi dans le contrat « clé en main ».

2.8.6 Augmentation des coûts

Les études qui servent de base à la détermination des conventions et à la détermination des coûts des ouvrages ont, au mieux, un degré de précision de 20 %. Le Ministre est autorisé à signer tout addenda impliquant une augmentation des coûts qui est égale ou inférieure à 20 % par rapport aux coûts indiqués à la convention (après indexation). Tout addenda entraînant une augmentation des coûts supérieure à 20 % devra faire l'objet d'une autorisation du Conseil du trésor avant que le Ministre ne soit autorisé à le signer.

SECTION 3
LE PLAN D'ÉQUIPEMENT

Le plan d'équipement du Ministère relatif au programme d'assainissement des eaux contient un cadre de référence définissant la problématique, les objectifs généraux, les objectifs spécifiques et les moyens pour atteindre ces objectifs.

Le plan d'équipement sera remis à jour annuellement et soumis au Conseil du trésor et au COMPADR pour approbation avant le 15 septembre.

Il fera état de la programmation déjà approuvée par le Conseil du trésor ainsi que des ajouts à la programmation que le Ministère entend proposer au cours des trois années financières subséquentes. Il indiquera pour chacune des années, les immobilisations globales en dollars constants qui découleront de l'ensemble de cette programmation.

SECTION 4
PROGRAMMATION

4.1 Programmation

Avant le 15 janvier de chaque année, le Ministre présente au Conseil du trésor et au COMPADR pour approbation, la programmation de l'année financière suivante. En plus d'indiquer les besoins de drainage et les projets déjà inscrits à la programmation, cette programmation indique les conventions signées à date et les nouveaux projets à inscrire à la programmation avec une estimation des coûts impliqués.

Les renseignements fournis sur ces projets sont la municipalité, sa population, le comté, la région administrative et le cours d'eau récepteur ainsi qu'un avis du ministre des Affaires municipales sur la possibilité d'endettement et de paiement de la municipalité.

4.2 Inscription à la programmation de réalisation

4.2.1 Municipalités de plus de 10 000 habitants

Pour les municipalités dont la population est supérieure à 10 000 habitants, le Ministère présente au Conseil du trésor pour approbation, les nouveaux projets inscrits à la programmation pour leur inscription à la programmation de réalisation. Pour chacun de ces projets, les informations suivantes sont transmises:

a) le nom de la corporation municipale;

b) la population desservie par le projet;

c) le cours d'eau récepteur;

d) la nature des travaux à réaliser;

e) l'estimation du coût total du projet;

f) une prévision des investissements annuels et des impacts sur le service de la dette du gouvernement;

g) un croquis d'implantation des ouvrages

4.2.2 Municipalités de moins de 10 000 habitants

Pour les municipalités dont la population est inférieure à 10 000 habitants, le ministre de l'Environnement, en signant une convention, l'inscrit de facto à la programmation de réalisation. Après signature de cette convention, le Ministère transmet au Conseil du trésor les informations énumérées à l'article 4.2.1.

SECTION 5
SUIVI DE LA PROGRAMMATION

Dans le cadre du suivi de la programmation, le Ministère revise trimestriellement l'état d'avancement des projets et publie, à l'intention des organismes centraux intéressés, un rapport donnant la liste de tous les projets inscrits à la programmation de même que les informations permettant le suivi du programme pour chacune des municipalités ayant signé une convention avec le Ministère.

Les prévisions du service de la dette sont calculées à l'aide des taux d'intérêt fournis par le Conseil du trésor.

Les rapports trimestriels couvrent les périodes se terminant les 30 juin, 30 septembre, 31 décembre et 31 mars de chaque année et sont produits dans les 15 jours ouvrables qui suivent ces dates.

SECTION 6
CONVENTIONS ANTÉRIEURES AU PRÉSENT CADRE DE GESTION

6.1 Dans le cas où le Ministre et une corporation municipale concluent un addenda à une convention signée ou déposée par le Ministère à la municipalité avant l'année en vigueur du présent cadre de gestion, les parties peuvent convenir d'appliquer la totalité ou une partie du présent cadre de gestion aux ouvrages visés dans ladite convention.

6.2 Tout ouvrage supplémentaire doit faire l'objet d'une nouvelle convention régie par le présent cadre de gestion.

SECTION 7
CONVENTION-TYPE

Convention-type relative à l'exécution et au financement des ouvrages requis pour le traitement des eaux usées municipales

APPENDIX 7

AVAILABLE ENERGY SURPLUS

Appendix 7

Maximum available energy surplus

The scenario #3 includes the construction of a 2.5 MW mini-hydroelectric power plant. Two 850 KW turbines will be installed at the start of the operations and an additional turbine will be added in 2016.

As for any kind of energy supply system , the size of the equipment is determined by the highest peak demand to be met. In 1984, this highest peak demand expected is 615 KW while it will be 669 KW in 1985.

The available power during these two years will be 1 700 KW, i.e. two 850 KW turbines. That is to say there will be 1085 and 1031 KW available for alternative uses in 1984 and 1985 respectively.

If this power was fully utilized, nine millions of KWh would be available at no cost. The table A-7 presents these theoretical maximum energy surplus.

The principal alternative use would obviously be heating. Heating energy demand is highly cyclical, requiring large quantity of energy during the winter period and practically nothing during the summer. The 1085 KW surplus would not be sufficient to meet the winter heating peak demand of 2270 KW and would not be required during the summer season.

This is why the maximum energy surplus of 9 millions of KWh in 1984 remains a theoretical calculation. Only a detailed energy management study will allow the determination of the realistic energy surplus available to the community.

MAXIMUM AVAILABLE ENERGY SURPLUS

TABLE A-7

	1984	1985	1986	1987	1988	1989	1990	1991	1992
AVAIL. POWER (KW)	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700
REQUIRED POWER (KW)	615	669	713	757	811	866	870	876	930
AVAIL. POWER (KW)	1,085	1,031	987	943	889	834	830	824	770
MAX. ENERGY AVAIL. (KWh)	9,507,238	9,030,586	8,648,527	8,261,167	7,786,140	7,310,149	7,266,790	7,222,421	6,743,398
	1993	1994	1995	1996	1997	1998	1999	2000	2001
AVAIL. POWER (KW)	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700
REQUIRED POWER (KW)	936	990	996	1,002	1,057	1,063	1,119	1,125	1,131
AVAIL. POWER (KW)	764	710	704	698	643	637	581	575	569
MAX. ENERGY AVAIL. (KWh)	6,696,937	6,215,774	6,167,123	6,117,338	5,632,773	5,580,642	5,093,675	5,039,086	4,993,225
	2002	2003	2004	2005	2006	2007	2008	2009	2010
AVAIL. POWER (KW)	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700
REQUIRED POWER (KW)	1,187	1,194	1,250	1,257	1,314	1,321	1,378	1,386	1,443
AVAIL. POWER (KW)	513	506	450	443	386	379	322	314	257
MAX. ENERGY AVAIL. (KWh)	4,492,442	4,433,947	3,940,470	3,879,218	3,382,918	3,318,778	2,819,524	2,752,360	2,250,012

MAXIMUM AVAILABLE ENERGY SURPLUS

TABLE A-7

	2011	2012	2013	2014	2015	2016	2017	2018	2019
AVAIL. POWER (KW)	1,700	1,700	1,700	1,700	1,700	2,550	2,550	2,550	2,550
REQUIRED POWER (KW)	1,501	1,509	1,567	1,575	1,634	1,692	1,701	1,760	1,820
AVAIL. POWER (KW)	199	191	133	125	66	858	849	790	730
MAX. ENERGY AVAIL. (KWh)	1,746,062	1,674,093	1,166,828	1,091,466	580,729	7,514,195	7,433,442	6,917,188	6,399,008
	2020	2021	2022	2023	2024	2025	2026	2027	2028
AVAIL. POWER (KW)	2,550	2,550	2,550	2,550	2,550	2,550	2,550	2,550	2,550
REQUIRED POWER (KW)	1,829	1,889	1,949	2,009	2,020	2,080	2,141	2,202	2,264
AVAIL. POWER (KW)	721	661	601	541	530	470	409	348	286
MAX. ENERGY AVAIL. (KWh)	6,312,478	5,790,312	5,266,082	4,739,742	4,644,861	4,114,149	3,581,175	3,045,887	2,508,229
	2029	2030	2031	2032	2033				
AVAIL. POWER (KW)	2,550	2,550	2,550	2,550	2,550				
REQUIRED POWER (KW)	2,325	2,338	2,400	2,463	2,525				
AVAIL. POWER (KW)	225	212	150	87	25				
MAX. ENERGY AVAIL. (KWh)	1,968,147	1,859,205	1,314,104	766,406	216,050				

Montreal, March 12 1985

Chief Jack Diamond
Waskaganish Band Council
Waskaganish, Quebec
JON 1RO

Re: Comparative study of energy systems for Waskaganish, Quebec

Dear Chief Diamond,

We are pleased to present our final report on the above mentioned study. We provide you with four bound copies of the report while a fifth reproducible copy is provided to EMR Canada for printing purposes.

We want to thank the Waskaganish Band Council for the opportunity that was given to Cogesult to assist them in the selection of the energy systems to be adopted for the next fifty years.

We remain

Very truly yours

Denis Charbonneau
Director
Economic and Financial studies

DC/vg